INFORMATION THEORY AND CODING
(ECEN 3105)

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) In a linear code, the minimum Hamming distance between any two code words is ----------minimum weight of any non-zero code word
(a) less than (b) greater than
(c) equal to (d) none of the above.

(ii) For a (7,4) cyclic code generated by $g(x)= x^3+x+1$. The syndrome for the error pattern $e(x) = x^4$ is
(a) 101 (b) 111 (c) 110 (d)011.

(iii) 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) $x^{n+2}+1$.

(iv) If m = 3, then length (n) of the BCH code
(a) 6 (b) 5 (c) 7 (d) none of these.

(v) The properties of cyclic code is /are
(a) Linear (b) Cyclic
(c) both a & b (d) none of these.

(vi) An encoder for a (4,3,5) convolution code has input order of
(a) 4 (b) 2 (c) 3 (d) 5.

(vii) The memory less source refers to
(a) No previous information
(b) No message storage
(c) Emitted message is independent of previous message
(d) None of the above.

(viii) The generator polynomial of a (7,4) cyclic code has a degree of
(a) 2 (b) 3 (c) 4 (d) 5.

(ix) Purpose of the source coding is to
(a)Increase the information transmission rate
(b)Decrease the information transmission rate
(c)Decrease the S/N ratio.
(d)Decrease the probability of error.

(x) What is the Hamming distance between 11011 & 11001
(a) 2 (b) 3 (c) 1 (d) 5.

Group – B

2. (a) Define entropy, channel capacity.

(b) Show that H(X, Y) = H(X/Y) + H(Y). where symbols have their usual meanings.

(c) An analog signal band limited to 5 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 the rate of information.

(2+2) + 3 + (3+2) = 12

3. (a) A DMS X has five symbols with probabilities of occurrence $P(x_1) = 0.4$; $P(x_2) = 0.18$; $P(x_3) = 0.17$; $P(x_4) = 0.15$; $P(x_5) = 0.1$; Construct the Shannon-Fano coding and determine
a>Average code length
b>Code efficiency.

(b) A channel has the following channel matrix:

$$[P(Y \mid X)] = \begin{bmatrix} 0.9 & 0.1 \\ 0.2 & 0.8 \end{bmatrix}$$

Draw the channel diagram.
Find $P(y_1)$ and $P(y_2)$ when $P(x_1) = P(x_2)=0.5$
Find the joint probabilities $P(x_1,y_2)$ and $P(x_2,y_1)$ when
$P(x_1) = P(x_2)=0.5$

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

Group – C

4. For a (6, 3) systematic linear block code, the three parity check bits c_4, c_5 & c_6 are formed following the equations:
$C_4 = d_1 \oplus d_3$, $C_5 = d_1 \oplus d_2 \oplus d_3$, $C_6 = d_1 \oplus d_2$. [Where C & d have their usual meaning]

i. Write down the generator matrix.

ii. Construct code words for $i_1 = [101]$, $i_2 = [110]$, $i_3 = [111]$.

Suppose that the received word is 010111. Decode this received word by finding the location of the error if any & the transmitted data.

4 + 4 + (2 + 2) = 12

5. (a) For a linear block code derive that $C.H^T = 0$, where symbols have their usual meaning.

(b) What is an equivalent code?

(c) Define minimum distance of a code-set. Minimum distance of a code is 7, determine the error- detection & error- correction capability of the code.

(d) Parity check matrix of a linear block code is

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

a> Determine the generator matrix.
b> Assuming that a vector [110111] is received, find the correct data.

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

Group – D

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

(b) Determine systematic & nonsystematic code words for i = (1101) for the (7,4) code with $g(x) = x^3+x+1$

6 + 6 = 12

7. (a) For a (2, 1, 2) convolution code, g^0 = (101) & g^1 = (110). Draw the encoder. Find the state diagram, for this convolution code.

(b) What is constraint length in convolution code? Compute the same for the above mentioned code.

3 +7 + 2 = 12

Group – E

8. (a) Determine the Galois Field elements of GF (24) for the corresponding polynomial $p(x) = x^4+x+1$

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

(c) Find the minimal polynomial of α4 in GF (2^4).

3+ (1+4) + 4= 12

9. Write short notes on (Any Three)
a> Hamming Code
b>Trellis diagram.
c>Shannon-Fano code.
d>Galois Field
e>Source coding.

(3 × 4) = 12

Department & Section	Submission Link
ECE A	https://classroom.google.com/u/1/w/MTQxODgxOTMzODM1/tc/MjY1MDE3NDk4ODY3
ECE B	https://classroom.google.com/w/MjQwNjM4ODQ0MDAx/tc/Mjc0ODYyNzU0NTc3
ECE C	https://classroom.google.com/w/MTI2NDI2OTE2ODYz/tc/Mjc0NDA3NjI0MjM5