B.TECH/IT/4TH SEM/INFO 2203 (BACKLOG)/2022

INFORMATION THEORY & CODING
(INFO 2203)

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) When the base of the logarithm is 2, then the unit of measure of information is
(a) Bits (b) Bytes (c) Nats (d) None of the mentioned.

(ii) Channel capacity is exactly equal to
(a) bandwidth of demand (b) amount of information per second
(c) noise rate in the demand (d) none of the above.

(iii) Which of the following is not a weighted code?
(a) Decimal Number system (b) Excess 3-code
(c) Binary number System (d) None of these.

(iv) The capacity of a binary symmetric channel, given H(P) is binary entropy function is
(a) 1 - H(P) (b) H(P) – 1 (c) 1 - $H(P)^2$ (d) $H(P)^2$ - 1.

(v) Which of the following code is a class of non-binary BCH?
(a) Hamming code (b) Hadamard code
(c) Golay code (d) Reed Solomon codes.

(vi) Information rate is defined as
(a) information per unit time
(b) average number of bits of information per second
(c) rH
(d) all of the above.

(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) Entropy of a random variable is
(a) 0 (b) 1 (c) infinite (d) cannot be determined.

(ix) The expected information contained in a message is called
(a) Entropy (b) Efficiency (c) Coded signal (d) None of the above.

(x) For BCH code if the received vector and the computed vector are r(x) and e(x) respectively, then the error free code vector is_____.
(a) r(x) *e(x) (b) r(x)/e(x) (c) r(x) + e(x) (d) None of these.

Group – B

2. A discrete source emits one of five symbols once every milliseconds with probabilities $P(X_1) = 1/2$, $P(X_2) = 1/4$, $P(X_3) = 1/8$, $P(X_4) = 1/16$, $P(X_5) = 1/16$. Construct binary code using Huffman encoding and find its efficiency and redundancy.
[(CO3)(Apply/IOCQ)]
12

3. (a) Find the rate of information transmission for the channel shown in figure 1. It is given that $P(x_1)=0.5$ and $P(x_2)=0.8$. Assuming $r_s=1000$ sym/s.

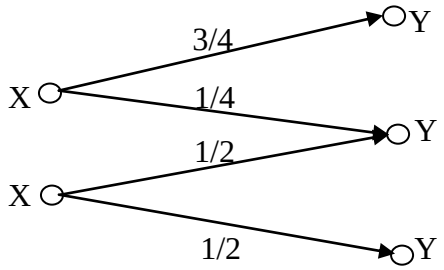

Fig. 1

[(CO3)(Apply/IOCQ)]

(b) Show that H(x,y)=H(x|y)+H(y)=H(y|x)+H(x). [(CO1)(Apply/IOCQ)]
6 + 6 = 12

Group – C

4. Write short notes on : (**Any Two**)
(i) Hamming Code. [(CO4)(Understand/LOCQ)]
(ii) CRC. [(CO4)(Understand/LOCQ)]
(iii) Block Code. [(CO2)(Understand/LOCQ)]
6 + 6 = 12

5. (a) Divisor polynomial of CRC is x^3+x+1. Find out the sent code-word of message 1 0 1 1 0 1 1 1. [(CO2)(Evaluate/HOCQ)]
(b) Find out the position of error bit of received message 1 1 0 1 0 1 1 0 1 0 110 1 using Hamming Code. [(CO2)(Evaluate/HOCQ)]
6 + 6 = 12

Group - D

6. (a) Construct the field GF(2^4) for the given polynomial $p(x) = x^4 + x + 1$. [(CO6)(Understand/LOCQ)]

   (b) Find (a) $\alpha^5 + \alpha^{12} + \alpha^{13} + 1$ (b) $\alpha^3 + \alpha^2 + 1$ (c) $\alpha^{11} + \alpha^7$ in GF(2^4). [(CO6)(Apply/IOCQ)]

   (c) Show that α^5 is a primitive element of GF(2^3). [(CO6)(Understand/LOCQ)]

   3 + 6 + 3 = 12

7. Write short notes on : (**Any Two**)
   (i) Minimal Polynomial. [(CO6)(Understand/LOCQ)]
   (ii) Generator Polynomial. [(CO6)(Understand/LOCQ)]
   (iii) Galois Field. [(CO6)(Understand/LOCQ)]

   6 + 6 = 12

Group – E

8. A rate 1/3 convolutional coder with consistent length of '3' uses for generating vectors g_1=(0 1 0), g_2=(1 0 1) and g_3=(1 0 1)
   (i) Sketch the encoder configuration.
   (ii) Draw the code tree (up to three levels), state diagram and Trellis diagram.
   (iii) If input message sequence is 10101, determine the output sequence of the encoder. [(CO5)(Evaluate/HOCQ)]

   [2 + (4 + 2 + 2) + 2] = 12

9 . Write short notes on following: (**Any Two**)
   (i) Trellis diagram. [(CO5)(Understand/LOCQ)]
   (ii) Code Tree. [(CO5)(Understand/LOCQ)]
   (iii) Viterbi algorithm. [(CO5)(Understand/LOCQ)]

   6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	43.75	31.25	25

Course Outcome (CO):

After the completion of the course students will be able to
1. Derive equations for entropy, mutual information and channel capacity for all types of channels.
2. Compare among different types of error correcting codes.
3. Evaluate the channel performance using Information theory.
4. Formulate the basic equations of linear block codes.
5. Apply convolution codes for performance analysis.
6. Design BCH code for Channel performance improvement

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question