ROLL NO. ________________

Code: AE73/AE125 Subject: INFORMATION THEORY & CODING

AMIETE – ET (Current & New Scheme)

Time: 3 Hours **December - 2017** Max. Marks: 100

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: (2×10)

a. The mutual information of the channel in terms of the entropy of the channel output as

(A) I(x;y)=H(y)-H(x/y) **(B)** I(x;y)=H(x)+H(x/y)
(C) I(x;y)=H(x)-H(x/y) **(D)** I(x;y)=H(y)+H(x/y)

b. Random attenuation changes within the transmission medium is

(A) Noise **(B)** Probability Error
(C) Fades **(D)** None of these

c. The Hamming distance between two binary codes 11011101 and 10011010 is

(A) 5 **(B)** 7
(C) 8 **(D)** 4

d. The probability of an event such as $P(B_j/A_i)$ that is the intersection of events from sub experiments is called the

(A) Conditional Probability **(B)** Joint Probability
(C) Marginal Probability **(D)** None of these

e. A generator polynomial g(X) of an (n,k) cyclic code is a factor of

(A) X^{n+1} **(B)** $X^{n}+1$
(C) X^{n-k-1} **(D)** $X^{n}-1$

f. The law of probability says that $P(A \cup B) =$

(A) P (A) + P(B) + P(AB) **(B)** P(A) ≥ 1 & P(B) ≥ 1
(C) 1 – P(AB) **(D)** P(A) + P(B) – P(AB)

g. Number of check bits in a (n, k) block code are

(A) q = n - k **(B)** q = n + k
(C) q = n/k **(D)** q = k/n

h. The entropy of a source that emits three symbols with probabilities $\frac{1}{2}, \frac{1}{4}$, and $\frac{1}{4}$ is

(A) 0.5 bits/symbol **(B)** 1.0 bit/ symbol
(C) 1.5 bits/symbol **(D)** 2.0 bits/symbol

i. One Hartley is _____ bits
(A) 1.443 **(B)** 2.56
(C) 4.23 **(D)** 3.32

j. A source S = {S_1, S_2, S_3} emits symbols with $P = \left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{4}\right\}$. The total information of all the messages is

(A) 2 bits **(B)** 3 bits
(C) 4 bits **(D)** 5 bits

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. State Shannon Hartley law. What are it's implications. **(8)**

b. The Input to a binary communication channel denoted by a random variable X, takes on one of two values'0'or '1'with probability ¾ and ¼ respectively. Due to errors caused by noise in the system, the output Y differs from input X occasionally. The behaviour of communication channel is modelled by conditional probabilities (p(y=1 / x=1) =3/4 and p (y=0 / x=0) = 7/8 **(8)**
Find p(y=1), p (y=0) and p(x=1/y=1)

Q.3 a. Let X and Y be defined by
$X = \cos\theta$ and $Y = \sin\theta$
Where θ is a random variable uniformly distributed over $[0,2\pi]$.
(i) Show that X and Y are uncorrelated
(ii) Show that X and Y are not independent **(8)**

b. Define probability density fundtion and distribution function and explain their properties briefly. **(8)**

Q.4 a. A source emits one of four possible messages m_1, m_2, m_3 and m_4 with probabilities ½ , ¼ , 1/8 and 1/8, respectively. Calculate the information content of each message and the average information content per message. **(8)**

b. Explain Markoff statistical model for information sources. **(8)**

Q.5 a. Define the term entropy. Compute the formula of entropy with its properties. **(8)**

b. What do you understand by source Encoding? State source coding theorem and find the relation between efficiency, entropy and average codeword length. **(8)**

Q.6 a. Show that (i) H(X|Y) = H(X) when X and Y are statistically independent, and (ii) H(X|Y) = 0 when X = Y. **(8)**

b. Explain the importance of a channel in a communication system with a comparison between continous & discrete channels. **(8)**

Q.7 a. Explain the following terms:
(i) Mutual information
(ii) Channel capacity **(8)**

b. Consider a binary symmetric channel (BSC) characterized by the transition probability 'p'. Plot the mutual information of the channel as a function of p_1, the a priori probability of symbol 1 at the channel input, for the transition probability p = 0, 0.1, 0.2, 0.3, 0.5. **(8)**

Q.8 a. Show that a linear block code with a minimum distance d_{min} can correct upto $[(d_{min} - 1) / 2]$ errors and detect upto $d_{min}-1$ errors in each codeword, where $[(d_{min} - 1) / 2]$ denotes the largest integer no greater than $(d_{min} - 1)/2$. **(8)**

b. Consider a (7, 4) Linear code whose generator matrix is

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

(i) Find all code vectors of this code
(ii) Find the parity check matrix for this code
(iii) Find d_{min}. **(8)**

Q.9 a. Factorize the polynomial $x^3 + x^2 + x + 1$ on GF(2). **(4)**

b. Consider the (3, 1, 2) convolution code with $g^{(1)} = (110)$, $g^{(2)} = (101)$ & $g^{(3)} = (111)$. (i) Draw the encoder circuit (ii) Find the codeword corresponding to the information sequence (11101). **(8)**

c. Explain Burst & random error correcting codes. **(4)**