ROLL NO. _____

Code: AE73/AE125 **Subject: INFORMATION THEORY & CODING**

AMIETE – ET (Current & New Scheme)

Time: 3 Hours **December 2016** **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 probability of an event A, P(A) obeys
(A) P(A)≥0 **(B)** P(A) <1
(C) P(A) >1 **(D)** None of these

b. A random process x(t) is said to be _____ if its statistics are not affected by a shift in the time origin
(A) Stationary **(B)** Stationary in the wide sense
(C) Stationary in the strict sense **(D)** Time invariant

c. The average information content per symbol is called
(A) Entropy **(B)** Mutual Information
(C) Information Rate **(D)** Source Entropy

d. The performance of the encoder is usually measured in terms of
(A) Coding rate **(B)** Coding Efficiency
(C) Bit rate **(D)** Spectral Efficiency

e. 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(y)+H(x/y)
(C) I(x;y)=H(x)-H(x/y) **(D)** I(x;y)=H(x)+H(x/y)

f. _____is a class of error correcting cyclic codes with $d_{min} \geq 2t+1$
(A) Reed Solomon Codes **(B)** BCH Codes
(C) Hamming Codes **(D)** Cyclic Codes

g. Channel capacity is measured in
(A) Frequency **(B)** Watts/Hz
(C) Bits per second **(D)** Symbols per second

h. If each of 2^k code words are expressed as a linear combination of K linearly independent code vectors, then the code is called
(A) Symmetric codes **(B)** Linear Codes
(C) Non linear block codes **(D)** Systematic linear block codes

i. The number of parity check bits of a q burst error correcting code must be
(A) n-k≤2q **(B)** n-k≥2q
(C) n-k<2q **(D)** n-k>2q

j. A linear block code with a minimum distance d_{min} can correct upto _____ errors and detect upto _____ errors
(A) $[(d_{min}-1)/2]$ and $d_{min}-1$ **(B)** $[(d_{min}-1)/2]$ and d_{min}
(C) $[(d_{min}+1)/2]$ and $d_{min}-1$ **(D)** $[(d_{min}-1)/2]$ and $d_{min}+1$

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

Q.2 a. Define Probability Mass Function. Consider two random variables x and y, derive the relationships involving joint, marginal and conditional mass functions. **(8)**

b. A random variable X takes on one of two values 0 or 1 with probabilities ¾ and ¼. Due to noise, the output Y differs from the input occasionally. The behaviour of the system is modelled by the conditional probabilities $P(Y=1/X=1)=\frac{3}{4}$ and $P(Y=0/X=0)=\frac{7}{8}$
Find P(Y=1) and P(Y=0). Also find $P(X=1/Y=1)$. **(8)**

Q.3 a. Give the notations and expression for statistical averages, stationary random process, Time average and Ergodicity. **(8)**

b. The joint pdf of random variables X and Y is $f_{x,y}(x,y)=\frac{1}{2}, \quad 0\le x\le y, 0\le y\le 2$.
(i) Find the marginal pdf's of $f_x(x)$ and $f_y(y)$.
(ii) Are X and Y independent? **(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. Define and derive the expression for entropy and information rate of Markov Process. **(8)**

Q.5 a. Apply Huffman Coding procedure for the following message ensemble: **(8)**

[X]= [x_1 x_2 x_3 x_4 x_5 x_6 x_7]

[P] = [0.4 0.2 0.12 0.08 0.08 0.08 0.04]. Take M=2. Determine the coding efficiency

b. Explain the procedure involved in Shannon Encoding algorithm. **(8)**

Q.6 a. Consider a binary symmetric channel with probability distribution input X and output Y as follows:
P(X=0/Y=0) = p; P(X=1/Y=0) = 1-p; P(X=1/Y=1) = p; P(X=0/Y=1) = 1-p; Find the rate of information transmission over this channel when p=0.9. Assume that the Bit rate is 1000/sec. **(8)**

b. Give the various properties of Mutual Information. **(8)**

Q.7 a. Derive the capacity of Gaussian Channel using Shannon Hartley Theorem. **(8)**

b. Calculate the bandwidth of the picture signal in a television. The following are the available data: The number of distinguishable brightness level is 10. The number of elements per picture frame is 300000 and the picture frames transmitted per second is 30 and the S/N required is 30 dB. **(8)**

Q.8 a. Consider a (7, 4) block code generated by $\begin{bmatrix} 1000110 \\ 0100011 \\ 0010101 \\ 0001111 \end{bmatrix}$. Explain, how the error syndrome S helps in correcting a single error? **(8)**

b. What are the methods of controlling errors? Give the types of errors. **(8)**

Q.9 a. Design an encoder for (7, 4) binary cyclic code generated by $g(x) = 1+x+x^3$ and verify its operation using the message vector (0101) **(8)**

b. Explain the encoder for Convolutional codes. **(8)**