ROLL NO. ______

Code: AE73 Subject: INFORMATION THEORY & CO

AMIETE – ET

Time: 3 Hours **DECEMBER 2013** 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. In a communication system, if the receiver knows the message being transmitted, then the amount of information carried is:

(A) 0 **(B)** 1
(C) ∞ **(D)** None of these

b. In Markoff model, transition of the system from K^{th} interval to $(k+1)^{th}$ is given by

(A) $P(K+1) = \phi^T P(K)$ **(B)** $P(K+1) = P(K) / \phi^T$
(C) $P(K+1) = \phi^T / P(K)$ **(D)** None of these

c. The capacity of a white band limited Gaussian channel is

(A) $C = B\log_2\left(1+\frac{S}{N}\right)$ **(B)** $C = B\log_2\left(1+\frac{N}{S}\right)$
(C) $C = \frac{S}{N}\log_2(1+B)$ **(D)** None of these

d. An analog signal having 4 KHz bandwidth is sampled at 1.25 times the Nyquist rate and each sample is quantized into one of 256 equally likely levels. If the samples are statistically independent, information rate of this source is

(A) 2000 bits/sec **(B)** 4000 bits/sec
(C) 6000 bits/sec **(D)** 80000 bits/sec

e. If an event is sure or impossible, then the entropy is

(A) 0 **(B)** ∞
(C) Not defined **(D)** None of these

f. If there are M number of equally likely messages, then entropy of the source is

(A) 0 **(B)** ∞
(C) $\log_2 M$ **(D)** None of these

g. Mutual information is always

(A) Positive **(B)** Negative
(C) Zero **(D)** ∞

h. The ratio of message bits and the encoder output bits is called

(A) Code word **(B)** Code rate
(C) Block length **(D)** None of these

i. 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

j. A cyclic code (15, 9) has a burst error correcting ability of 3 bits. It's burst error correcting efficiency will be

(A) 25% **(B)** 50%
(C) 75% **(D)** 100%

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. **(6)**

b. In a facsimile transmission of a picture, there are about 2.25×10^6 picture elements per frame. For a good reception, twelve brightness levels are necessary. Assuming all these levels are equiprobable, calculate the channel bandwidth required to transmit one picture in every three minutes for a signal to noise power ratio of 30 dB. If SNR requirement increases by 40 dB, calculate the new bandwidth. Explain the trade-off between bandwidth and SNR by comparing two results. **(10)**

Q.3 a. Show that the mutual information is always non-negative and we cannot lose information by observing the output of a channel. **(6)**

b. What is binary symmetric channel? Find the rate of information transmission over this channel. **(10)**

Q.4 a. Discuss how would you compute the entropy and information rate of Mark-off source. **(5)**

b. Explain measure of information and derive expression for it? **(6)**

c. Find the entropy of a source that emits one of three symbols A, B, and C in a statistically independent sequence with probabilities $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{4}$ respectively. **(5)**

Q.5 a. Give the different properties of entropy of zero memory source. **(6)**

b. Design a source encoder for the information source given in fig.1 compare the average output bit rate and efficiency of the coder for N = 1, 2 and 3. **(10)**

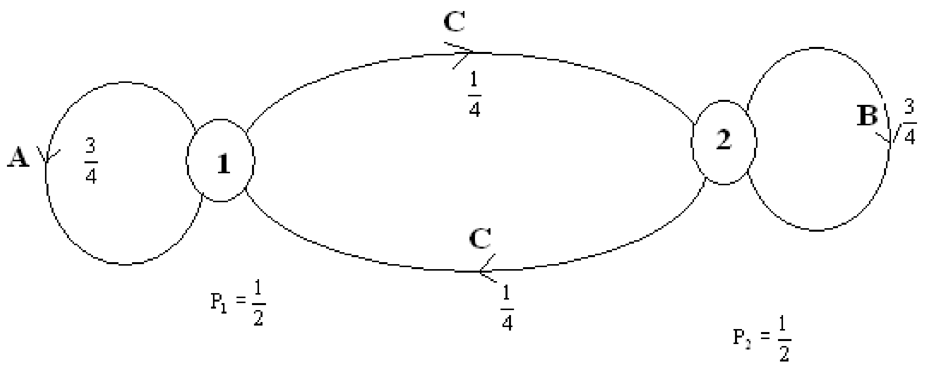

Fig.1

Q.6 a. Draw and explain relationships involving joint, marginal and conditional probabilities. **(6)**

b. Binary data are transmitted over a noisy communication channel in blocks of 16 binary digits. The probability that a received binary digit is in error due to channel noise is 0.1. Assume that the occurrence of an error in a particular digit does not influence the probability of occurrence of an error in any other digit within the block (i.e., errors occur in various digit positions within a block in a statistically independent fashion). **(10)**

(i) Find the average (or expected) number of errors per block.

(ii) Find the variance of the number of errors per block.

(iii) Find the probability that the number of errors per block is greater than or equal to 5.

Q.7 a. Compare uniform pdf and Gaussian pdf. **(10)**

b. Define stationarity, Time Averages and Ergodicity. **(6)**

Q.8 a. Prove that all the 2^k n- tuples of a co-set have the same syndrome and the syndromes of different co-sets are different. **(6)**

b. The generator polynomial of a (7, 4) cyclic code is G (p) = $p^3 + p + 1$. Find all the code vectors for the code in non-systematic form. **(10)**

Q.9 A rate 1/3 convolution encoder has generating vectors as g_1 = (100), g_2 = (111) and g_3 = (101)

(i) Sketch the encoder configuration

(ii) Draw the code tree, state diagram and trellis diagram

(iii) If input message sequence is 10110, determine the output sequence of the encoder. **(16)**