ROLL NO. ___________________

Code: AE73 Subject: INFORMATION THEORY & CODING

AMIETE – ET (NEW SCHEME)

Time: 3 Hours **DECEMBER 2011** **Max. Marks: 100**

NOTE: There are 9 Questions in all.

- **Please write your Roll No. at the space provided on each page immediately after receiving the Question Paper.**
- **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. PDF of Gaussian distribution is given by

(A) $\frac{1}{\sqrt{2\pi\sigma}}\exp^{\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right]}$ **(B)** $\frac{1}{\sqrt{2\pi}\,\sigma}\exp^{\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right]}$

(C) $\frac{1}{2\pi\sigma}\exp^{\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)\right]}$ **(D)** $\frac{1}{\sqrt{2\pi\sigma}}\exp^{\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)\right]}$

b. Entropy of a binary source with probabilities $[P]=\left[\frac{7}{16},\frac{9}{16}\right]$ is

(A) 0.389 **(B)** 0.689
(C) 0.989 **(D)** 0.589

c. One Hartley is ______ bits

(A) 1.443 **(B)** 2.56
(C) 4.23 **(D)** 3.32

d. For binary code with q symbols and world length l_1, l_2…..l_q, Kraft inequality equation becomes

(A) $\sum_{i=1}^{q} 2^{l_i} \le 1$ **(B)** $\sum_{i=1}^{q} 2^{-l_i} \le 1$

(C) $\sum_{i=1}^{q} \frac{1}{2^{-l_i}} \le 1$ **(D)** $\sum_{i=1}^{1} 2^{-q_i} \le 1$

e. Coding efficiency for source with entropy H(S) and average length L is

(**A**) $H(S) \bullet L$ (**B**) H(S)-L

(**C**) H(S)+L (**D**) $\frac{H(S)}{L}$

f. Mutual information of the channel is

(**A**) H(A)+H(A/B) (**B**) $\frac{H(A)}{H(A/B)}$

(**C**) H(A)-H(A/B) (**D**) $H(A) \bullet H(A/B)$

g. The channel capacity in infinite bandwidth AWGN is given by _______ bits/sec

(**A**) $C_{\infty} = B \cdot \frac{S}{N} \log_2 e$ (**B**) $C_{\infty} = \frac{1}{B}\frac{S}{N} \log_2 e$

(**C**) $C_{\infty} = \frac{1}{B}\frac{N}{S} \log_{10} e$ (**D**) $C_{\infty} = B\frac{S}{N} \log_{10} 2$

h. A (n,k) block code consists of ________ number of check bits added to k number of information bits.

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

i. Hamming weight of a code vector is the number of ______ components of C

(**A**) Zero (**B**) Non-zero
(**C**) Zero and non-zero (**D**) None

j. The generator polynomial g(x) of (n,k) cycle code is a factor of _____

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

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

Q.2 a. Define Joint probability and Marginal probability. **(6)**

b. A random variable binary input x to a communication system takes '0' or '1' with probabilities $\frac{3}{4}$ and $\frac{1}{4}$ respectively. Due to noise output y differs from input x occasionally. The behaviour of communication system is modelled by $P(y = 1 | x = 1) = \frac{3}{4}$ and $P(y = 0 | x = 0)\frac{7}{8}$. Find P(y=1) and P(y=0). **(6)**

c. A box with 1 dozen balls has 3 red, 4 green and 5 yellow balls. A sample of size 4 is made. The order is [R_1, G_2, G_3, Y_4]. Find the probability of this event. **(4)**

Q.3 a Define probability density function, cumulative distribution function and explain its properties briefly. **(8)**

b. A random process X(t) is defined by $X(t) = 2\cos(2\pi t + y)$, where y is discrete random variable with $P(y=0)=\frac{1}{2}$ and $P(y=\frac{\pi}{2})=\frac{1}{2}$. Find $\mu_x(1)$ and $R_{XX}(0,1)$. **(8)**

Q.4 a. Define entropy and Information rate. **(4)**

b. The output of information source consists of 150 symbols. 32 of which occur with a probability of 1/64 and remaining 118 occur with a probability of 1/236. The source emits 2000 symbols/sec. Assuming that the symbols are chosen independently. Find the average information rate of this source. **(6)**

c. Compute the state probabilities for the state diagram of Markov source shown in Fig.1. **(6)**

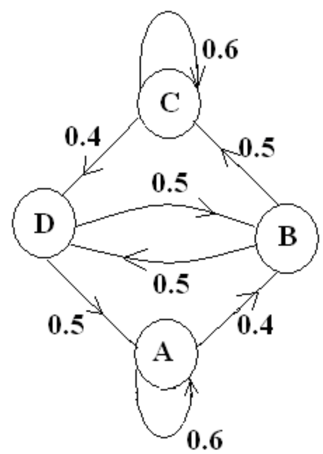

Fig.1

Q.5 a. Define
(i) Coding efficiency (ii) Redundancy in coding. **(6)**

b. Apply Shanon's encoding algorithm to the following message and find Coding efficiency and redundancy.

Symbols	S_1	S_2	S_3
Probability	0.5	0.3	0.2

(10)

Q.6 a. With neat sketch explain discrete Binary symmetric communication channel. Also find its channel matrix. **(8)**

b. Find the channel capacity of a uniform channel where matrix is given.

$$P(y_j/x_i) = \begin{bmatrix} 0.6 & 0.2 & 0.2 \\ 0.2 & 0.6 & 0.2 \\ 0.2 & 0.2 & 0.6 \end{bmatrix}$$

with r_T =1000 messages/sec **(8)**

Q.7 a. State the Shanon's Hartley law and obtain expression for channel capacity for continuous channel. **(8)**

b. A Gaussian channel has a 10 MHz Bandwidth. If (S/N) is 100, calculate the channel capacity and maximum information rate. **(8)**

Q.8 a. The generator matrix for (6,3) block code is given below. Find all code vectors.

$$G = \begin{bmatrix} 100101 \\ 010011 \\ 001110 \end{bmatrix}$$ **(8)**

b. Prove that minimum Hamming weight of a linear block code C is equal to smallest number of column of H-matrix that add up to zero. **(8)**

Q.9 a. The generator polynomial of a cyclic code is $g(x) = 1+x+x^3$. Obtain one code vector in non systematic and systematic form. **(6)**

b. For the convolutional encoder diagram as shown in Fig.2, the information sequence is d=10011. Find the output sequence using Time domain approach. **(10)**

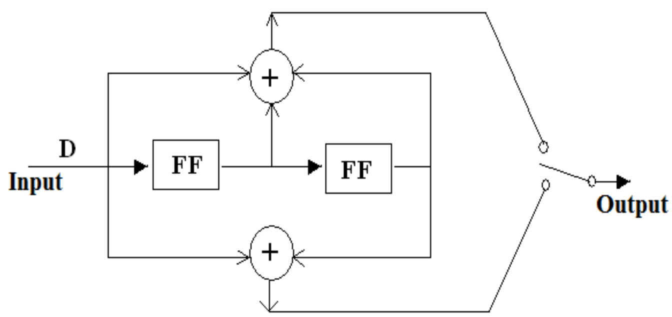

Fig.2