ROLL NO.

Code: AE73 Subject: INFORMATION THEORY & CODING

AMIETE – ET (NEW SCHEME)

Time: 3 Hours **JUNE 2012** **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. A town has two fire engines operating independently. The probability that a specific fire engine is available when needed is 0.99. The probability that neither is available when needed is

(A) 1 **(B)** 0
(C) 0.0001 **(D)** 0.1

b. Let x be a random variable that denotes the life in hours of a certain electronic

The PDF is given by $f(x) = \frac{20{,}000}{x^3}$ for $x > 100$

$= 0$ elsewhere

The expected life of their device is

(A) 200 Hrs **(B)** 100 Hrs
(C) 400 Hrs **(D)** zero

c. The average number of radioactive particles passing through a counter during 1m sec in a lab experiment is 4. The probability that 6 particles enter the counter in 1m sec is

(A) 0.284 **(B)** 0.1042
(C) 0.2401 **(D)** 0.44802

d. A discrete source emits one of six symbols once every m sec. The symbols probabilities are $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}$ & $1/32$ respectively. The source entropy is

(A) 1 **(B)** 0
(C) 1.9375 **(D)** 5.7391 bits/ msg symbol

e. A source produces two symbols A & B with probabilities 0.05 & 0.95 respectively. The average length of the message is

(A) 0.05 **(B)** 0.95
(C) 0 **(D)** 1 bits/msg symbol

f. A sources produces two independent symbols with probabilities 0.4 & 0.6 respectively. The source has an efficiency of

(A) 97.095 **(B)** 95.097
(C) 0 **(D)** 1

g. A continuous random variable has a distribution as

$$f_X(x) = \frac{1}{a} \qquad 0 \le x \le a$$
$$= 0 \text{ otherwise}$$

The differential entropy is

(A) $\log_a 2$ **(B)** $\log_2 a$
(C) 0 **(D)**1 bit / sample

h. A voice grade channel of a telephone network has a bandwidth of 3.4 kHz. The capacity of the telephone channel for a S/N ratio of 30 dB is

(A) 33889 **(B)** 88339
(C) 99833 **(D)** 0 bits/ sec

i. For a systematic (6,3) linear block code, the number of valid code words is

(A) 2 **(B)** 3
(C) 6 **(D)** 8

j. A (15,9) cyclic code has a burst error correcting ability of 3. The % burst error correcting efficiency of this code is

(A) 60 **(B)** 75
(C) 100 **(D)** 0

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

Q.2 a. State and prove Baye's Theorem **(6)**

b. Three machines A, B & C produce respectively 50%, 30% and 20% of the total number of items in a factory. The percentage of defective outputs of these machines are 3%, 4% & 5% respectively.
(i) If an item is selected at random what is the probability of that the item is defective
(ii) If the item selected at random is found to be defective what is the probability that the item was produced by machine A, by machine B or machine C? **(10)**

Q.3 a. Define "ENTROPY" of an information source. Derive an expression for the average information content of symbols in long independent sequences. **(8)**

b. A fair coin is tossed repeatedly. **(8)**

Let A = {**Event of getting 3 heads out of 5 trials**

B = {**Event of getting 5 heads out of 8 trials**

Which event conveys more information? Support your answer by numerical computation of respective amounts of information.

Q.4 a. State & prove KRAFT inequality **(8)**

b. Consider a binary block code with 2^n code words of same length, n show that the KRAFT in equality is satisfied for such a code **(8)**

Q.5 a. With relevant equations explain the Shannon's noise less coding theorem. **(8)**

b. Consider a discrete memory less source whose alphabet consists of K equiprobable symbols **(8)**

(i) Explain why the use of a fixed length code for the representation of such source is as efficient as any code can be.

(ii) What conditions have to be satisfied by K and the code length for the coding efficiency to be 100%.

Q.6 a. Define the following

(i) Priori Entropy (ii) Posterior Entropy

(iii) Equivocation (iv) Mutual information

(v) Joint Entropy **(10)**

b. With usual notations, prove the following: $H(x,y)=H(x/y)+H(y)$ **(6)**

Q.7 a. Explain the importance of a channel in a communication system with a comparison between continuous & discrete channels. **(6)**

b. An analog signal has a 4 kHz bandwidth. The signal is sampled at 2.5 times the Nyquist rate & each sample is quantized into 256 equally likely levels. Assume that the successive samples are statistically independent. **(10)**

(i) Find the information rate of this source

(ii) Can the output of this source be transmitted without errors over a gaussian channel of bandwidth 50 kHz and S/N ratios of 20 dB.

(iii) If the output of this source is to be transmitted without error over an analog channel having S/N =10 dB, compute the bandwidth requirement of the channel.

Q.8 a. Construct groups under mod5 addition & multiplication. **(4)**

b. Construct the table for GF (2^3) based on the primitive polynomial $P(x) = 1 + x + x^3$ **(4)**

c. Consider a (8,4) LBC with the generator matrix

$$G = \begin{bmatrix} 1\mathbf{100}\ \mathbf{1000} \\ \mathbf{1101}\ \mathbf{0100} \\ \mathbf{0111}\ \mathbf{0010} \\ \mathbf{1001}\ \mathbf{0001} \end{bmatrix}$$ **(8)**

(i) Obtain 'H' matrix & all possible code words
(ii) Draw the encoder & syndrome calculation circuits

Q.9 Consider the (2,1,5) non-systematic feed forward convolution encoder with $g^{(1)} = (101101)$, $g^{(2)} = (110011)$
(i) Draw the encoder circuit
(ii) Find the generator matrix
(iii) Find the output sequences $v^{(1)}$, $v^{(2)}$ & v corresponding to an input sequence x = (1101)
(iv) Draw the code tree & trace the code **(16)**