ROLL NO.

Code: AE73/AE125 Subject: INFORMATION THEORY & CODING

AMIETE – ET (Current & New Scheme)

Time: 3 Hours **JUNE 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 such as A_iB_j that is the intersection of events from sub experiments is called the
(A) Marginal Probability **(B)** Joint Probability
(C) Conditional Probability **(D)** None of these

b. A random process X(t) statistics not affected by a shift in the time origin is known as
(A) Ergodicity **(B)** Time Averages
(C) Gaussian Random process **(D)** None of these

c. A source puts out one of five possible messages during each message interval. The probability of these messages are are p_1 = ¼, p_2 = 1/16. The information content of each of these messages are
(A) 1bit, 2bits **(B)** 2bits, 8bits
(C) 2bits, 4bits **(D)** None of these

d. The equiprobable events have _____value of entropy
(A) Minimum **(B)** Maximum
(C) Unity **(D)** None of these

e. A discrete source emits one of five symbols once every millisecond. The symbol probabilities are ½, ¼, 1/8, 1/16, and 1/16 respectively. The source entropy is
(A) 0.875 bits/symbol **(B)** 1875 bits/symbol
(C) 1.875 bits/symbol **(D)** None of these

f. Random attenuation changes within the transmission medium is
(A) Noise **(B)** Fades
(C) Probability Error **(D)** None of these

g. In Analog Communication Systems performance measuring parameter is
(A) Signal to Noise Ratio (SNR)
(B) Probability Density Function (PDF)
(C) Cumulative Distribution Function (CDF)
(D) None of these

h. The effect of noise can be minimized by
(A) Modulation **(B)** Filtering
(C) Both (A) & (B) **(D)** None of these

i. Number of check bits in a (n, k) linear block code are
(A) q = n/k **(B)** q = n + k
(C) q = n - k **(D)** q = k/n

j. (15,11) Linear Block Code is _____
(A) Hamming Code **(B)** Having Single Error Correction
(C) Both (A) & (B) **(D)** None of these

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

Q.2 a. Explain the probability mass function and variance of discrete random variable. Also discuss its properties. **(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. Explain ergodic, wide sense stationery and strict sense random process **(8)**

b. Consider the following random process X(t) = A cos $(\omega_c t + \theta)$ **(8)**
where A and ω_c are constant, θ is random variable with a uniform pdf.
$$\int \theta(\theta) = 1/2\pi, -\pi < \theta < \pi$$
(i) Find the mean, autocorrelation function and pdf of X(t)
(ii) Find the autocorrelation function by time averaging and show that
$< Rxx(\tau) >= Rxx(\tau)$

Q.4 a. For a binary symmetric channel P(X=0) = ½ and P(X =1) =1/2. Find the rate of information transmission over this channel when p=0.9, 0.8, and 0.6; Assume that the symbol rate is 1000/sec. **(8)**

b. Consider an information source modelled by a discrete ergodic Markoff random process whose graph shown in Fig 1 below. Find the source entropy H and the average information content per symbol in messages containing one, two and three symbols, Find G_1,G_2,and G_3. **(8)**

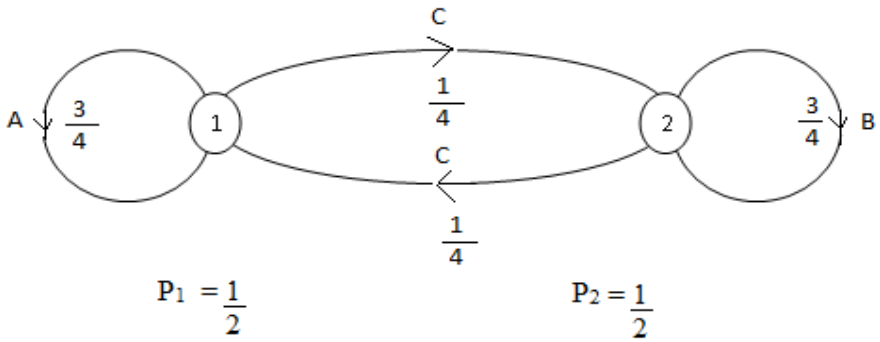

Fig 1

Q.5 a. Calculate the capacity of the discrete channel shown in Fig 2. Assume $r_s = 1$ symbol/sec. **(8)**

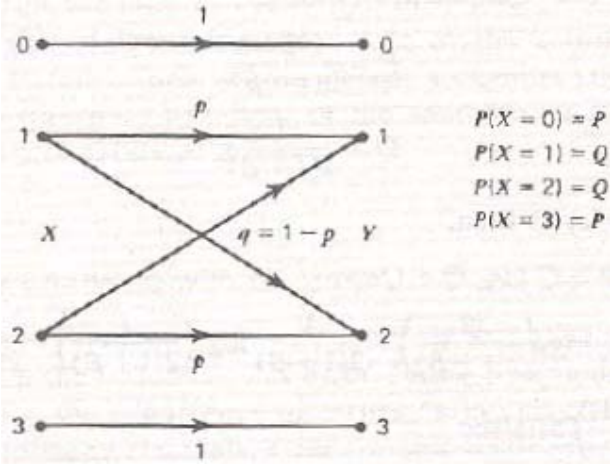

Fig 2

b. Explain Prefix coding with an example. **(8)**

Q.6 a. Draw and explain the block diagram of Characterization of a binary symmetric communication channel and binary discrete communication channel. Also find its channel matrix. **(10)**

b. Show that H(X,Y) = H(X) + H(Y| X) = H(Y) + H(X|Y) **(6)**

Q.7 a. Calculate the capacity of a Gaussian channel with a bandwidth of 1MHz and S/N ratio of 30 dB. How long will it take to transmit one million ASCII characters over in this channel. **(8)**

b. Explain in detail Mutual Information and Channel Capacity Theorem. **(8)**

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

$$G = \left[\begin{array}{ccc|ccc} 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{array}\right]$$

Find all code vectors of this code

b. A linear block code with a minimum distance dmin can correct up to [(d_{min} – 1) / 2] errors and detect up to d_{min} -1 errors in each codeword, where [(d_{min} -1) / 2] denotes the largest integer no greater than (d_{min} -1)/2. **(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 Maximum Likelihood Decoding of Convolutional Codes. **(8)**