ROLL NO. ______________

Code: AE73 **Subject: INFORMATION THEORY & CO**

AMIETE – ET

Time: 3 Hours **DECEMBER 2012** **Max. Marks: 10**

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. Two dies are thrown simultaneously. The probability of getting a 5 is

(A) $\frac{1}{6}$ **(B)** $\frac{1}{7}$

(C) $\frac{1}{8}$ **(D)** $\frac{1}{9}$

b. A random process X(t) is defind by X(t)=2 cos(2πt+Y) with discrete random variable $P(Y=0)=\frac{1}{2}$ and $P(Y=\frac{\pi}{2})=\frac{1}{2}$. The value of $\mu_x(1)$ is

(A) $\frac{1}{2}$ **(B)** 1

(C) $-\frac{1}{2}$ **(D)** Zero

c. The entropy of a source that emits three symbols with probabilities $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{4}$ is

(A) 0.5 bits/symbol **(B)** 1.0 bit/ symbol

(C) 1.5 bits/symbol **(D)** 2.0 bits/symbol

d. The PDF of a Gaussian random variable X is $P_X(x)=\frac{1}{3\sqrt{2\pi}}\ e^{-(x-4)^2/18}$. The probabilities of the event {X=4} is

(A) $\frac{1}{2}$ **(B)** $\frac{1}{3\sqrt{2\pi}}$

(C) 0 **(D)** $\frac{1}{4}$

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e. A communication channel with AWGN has bandwidth of 4KHz and SNR 15. Its channel capacity is

(A) 1.6 kbps **(B)** 16 kbps
(C) 32 kbps **(D)** 256 kbps

f. The channel capacity of a 5KHz bandwidth binary system is

(A) 10,000 bits/sec **(B)** 5000 bits/sec
(C) 8000 bits/sec **(D)** 4000 bits/sec

g. A random experiment has 16 equally likely outcomes. The information associated with each outcome is

(A) 16 bits **(B)** 8 bits
(C) 4 bits **(D)** 2 bits

h. The generator polynomial g(x) and parity check polynomial h(x) for a(n, k) cyclic code are related by

(A) $g(x) = (1 + x^n).h(x)$ **(B)** $h(x) = (1 + x^n).g(x)$
(C) $g(x).h(x) = (1 + x^n)$ **(D)** $g(x).h(x) = \frac{1}{1 + x^n}$

i. For average code length L, the code efficiency is

(A) $\frac{L_{min}}{L}$ **(B)** $\frac{L_{max}}{L}$
(C) $\frac{1}{L_{min}}$ **(D)** $\frac{1}{L_{max}}$

j. If K is message bit and n is encoder output bit, then code rate r is

(A) $\frac{K}{n}$ **(B)** $\frac{n}{K}$
(C) $\frac{1}{nK}$ **(D)** nK

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

Q.2 a. Explain probability mass function and statistical average of discrete random variables **(8)**

b. Three coins are tossed simultaneously. If number heads is the random variable, find the probability function for this random variable. **(8)**

Q.3 a. Explain stationarity, Time averages and Ergodicity. **(6)**

b. The probability density function is $f_X(x) = a\ e^{-b|x|}$ Determine the following
(i) The relation between a and b
(ii) Cumulative distribution function
(iii) The probability of outcome lying between 1 and 2 **(10)**

Q.4 a. Verify the expression $0 \le H(x) \le \log_2 M$. Where M is size of alphabet X. **(1**

b. A high resolution black and white TV picture consists of 2×10^6 picture elements and 16 different brightness levels. The pictures are repeated at a rate of 32 per second. Assuming all picture elements to be independent and all levels equally likelihood, calculate the average rate of information conveyed by this TV picture source. **(6)**

Q.5 a. Explain Shannon's Encoding Algorithm. **(8)**

b. A DMS X has five equally likely symbols with probability 0.2, construct a Huffman code for X and calculate the code efficiency of the code. **(8)**

Q.6 a. With the help of block diagram show the characterization of a binary communication channel. **(8)**

b. For a lossless channel, Prove that $H(X|Y) = 0$ **(4)**

c. Verify the expression I(X;Y)= I(Y;X) **(4)**

Q.7 a. Show that the channel capacity of a channel with bandwidth B is **(10)**

$$C = B \log_2\left(1 + \frac{S}{N}\right)$$

Where S and N are the average signal power and noise power respectively.

b. A CRT is connected to computer through a device having a usable bandwidth of 3000Hz and output S/N of 10 dB and is used to enter alphanumeric data. Assume that the CRT terminal has 128 characters and that the data sent from the terminal consist of independent sequences of equiprobable characters. Find:

(i) The channel capacity.

(ii) Maximum rate at which data can be transmitted from the terminal to the computer without errors. **(6)**

Q.8 a. Define codeword, code rate, channel data scale and Hamming distance. **(8)**

b. Design a linear block code with a minimum distance of three and a message block size of eight bits. **(8)**

Q.9 a. What are convolution codes? Write their advantages and disadvantages. **(8)**

b. Design a syndrome calculator for a (7,4) cyclic hamming code generated by polynomial G(P)= $P^3 + P + 1$. Evaluate the syndrome for Y=(1001101). **(8)**