ROLL NO. _____

Code: AE73/AE125 Subject: INFORMATION THEORY & CODING

AMIETE – ET (Current & New Scheme)

Time: 3 Hours **JUNE 2017** **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. If A and B are two events with P(A)=3/8, P(B)=1/2 and P(A∩B) =1/4, find P(AUB).
(A) 1/3 **(B)** 3/8
(C) 5/8 **(D)** ½

b. The channel capacity is a measure of
(A) Entropy rate
(B) Maximum amount of information that the channel can handle
(C) Information contents of messages transmitted in a channel
(D) None of these

c. If the channel is bandlimited to 6 kHz and signal to noise ratio is 16, what would be the capacity of channel?
(A) 15.15 kbps **(B)** 24.74 kbps
(C) 30.12 kbps **(D)** 52.18 kbps

d. The efficiency of Huffman code is linearly proportional to
(A) average length of code **(B)** average entropy
(C) maximum length of code **(D)** None of these

e. The variable length blocks in Lempel-Ziv encoding are known as _____ .
(A) Messages **(B)** Blocks
(C) Phrases **(D)** None of these

f. A linear block code (7, 4) has a rate of
(A) 7 **(B)** 4
(C) 1.75 **(D)** 0.571

g. For designing of (4,1) cyclic code, what would be the order of the generator polynomial?
(A) 1 **(B)** 3
(C) 4 **(D)** 5

h. Find the number of possible detectable errors for an (n, k) linear code over GF(2).
(A) 2^n **(B)** 2^{n-k}
(C) 2^k **(D)** None of these

i. While representing the convolutional code by (n, k, m), what does 'm' signify or represent in it?
(A) Coded bits **(B)** Memory order
(C) Message bits **(D)** All of these

j. Let GF (q) be the base field and GF (q^m) be its extension field. For *m=4*, find the block length of BCH code if q=2.
(A) 4 **(B)** 16
(C) 15 **(D)** None of these

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

Q.2 a. Discuss the main objectives of Information Theory and Coding and define continuous and discrete random variables. **(8)**

b. What are the ways to measure probability? Let X = { x_1…….. x_n} and Y = { y_1…… y_n } be two random variables. Find the marginal probability of P($x=x_i$, y). **(8)**

Q.3 a. Explain wide sense stationary random process. Consider a random process $X(t) = A\cos(\omega t + \phi)$ where A and ω are constants and ϕ is a uniform random variable over $[-\pi, \pi]$. Show that $X(t)$ is a wide sense stationary random process. **(8)**

b. Explain the transformations of Random variables with the help of one example. **(8)**

Q.4 a. Consider a DMS with source alphabet S = {s_0, s_1, s_2} with probabilities ¼, ¼ and ½ respectively. Find H(S), H(S^2). **(4+4)**

b. What is discrete memoryless source (DMS)? How do you calculate the capacity of a DMS? Prove that H(X)≥0, where m is the size of an alphabet of X. **(8)**

Q.5 a. State source coding theorem and its importance. Is prefix code an instantaneous code? Justify your answer. **(8)**

b. Does Huffman encoding satisfy uniqueness property? Consider a source (S) of symbols A, B, C, D and with probabilities 0.3, 0.15, 0.1, 0.25, 0.2 respectively. Design Huffman code for the given source S. Find its code efficiency. **(8)**

Q.6 a. Define channel. Give some examples of channel. How do you determine that a communication channel is:
(i) lossless (ii) noiseless?

b. Show that I(X, Y) = H(X) – H(X|Y) **(8)**

Q.7 a. State the Shannon-Hartley channel capacity theorem, hence show that channel capacity of infinite bandwidth is given as $1.44\left(\frac{E_s}{\eta}\right)$ where $\frac{\eta}{2}$ is the noise power spectral density and E_s is the signal Power. **(8)**

b. Draw and explain bandwidth-efficiency diagram. **(8)**

Q.8 a. Design a linear block code with a minimum distance of 3 and a message block size of 8 bits. **(8)**

b. Consider a (6, 3) linear code with **(8)**

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$$

(i) Is the code a Hamming code? Verify.
(ii) Find the parity check matrix for the given G.
(iii) Find d_{min}. Also, check how many errors the code can correct.

Q.9 a. Let us consider a (7,4) cyclic code with generator polynomial $g(x) = 1 + x + x^3$. Derive the generator matrix G for the given code. Also, let the message u=1001 be sent. Find the encoded code word for u. **(8)**

b. Write short notes on the followings: **(4+4)**
(i) BCH code
(ii) Convolutional code and its encoding