Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(ECE)/SEP.SUPPLE/SEM-7/EC-703/2012

2012

CODING AND INFORMATION THEORY

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

$10 \times 1 = 10$

i) A communication channel with additive white Gaussian noise has a bandwidth of 4 kHz and an SNR of 1·5. Its channel capacity is

a) 1·6 kbps b) 16 kbps

c) 32 kbps d) 256 kbps.

ii) A source delivers symbol x_1, x_2, x_3 and x_4 with probabilities $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{8}$ respectively. The entropy of the system is

a) 1·75 bits/sec b) 1·75 bits/symbol

c) 1·75 symbol/sec d) 1·75 symbols/bit.

iii) The rate at which information can be passed through a telecommunication channels depends on the

a) carrier frequency b) bandwidth

c) transmission time d) transmission power.

iv) We use an cryptography method in which the plaintext AAAAAA becomes the cipher text BCDEFG. This is probably

a) monoalphabetic substitution

b) polyalphabetic substitution

c) transpositional

d) none of these.

v) The purpose of source coding is to

a) increase the information transmission rate

b) decrease the S?N rate

c) decrease the information transmission rate

d) decrease the probability of error.

vi) The rate at which information can be passed through a telecommunication channel depends on the

a) carrier frequency b) bandwidth

c) transmission time d) transmitter power.

vii) The channel capacity under the Gaussian noise environment for a discrete memory less channel with a bandwidth of 4 MHz and SNR of 31 is

a) 20 mbps b) 4 mbps

c) 8 mpbs d) 4 kbps.

viii) Consider the parity check matrix $H = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 1 \end{bmatrix}$ and the received vector $r = (001110)$. The syndrome is given by

a) (110) b) (100)

c) (111) d) (101).

ix) Measure of information $I(m_k)$ of a message m_k with probability p_k is given by

a) $\log_b\left(\frac{1}{p_k}\right)$ b) $\log_b(p_k)$

c) $\log_b(1-p_k)$ d) $\log_b\left(\frac{1}{(1-p_k)}\right)$.

x) Chain search is used for decoding

a) linear block codes b) BCH codes

c) convolution codes d) none of these.

xi) Cyclic Redundancy Check is a type of

a) convolution code b) cyclic code

c) parity check code d) none of these.

xii) The entropy of information source is maximum when symbol occurrences are

a) equiprobable b) different probability

c) both (a) and (b) d) none of these.

xiii) A message that is sent in cryptography is known as

a) plain text b) cipher text

c) cracking d) decryption.

xiv) The generator polynomial of a cyclic code is a factor of

a) $X^n + 1$ b) $X^{(n+1)} + 1$

c) $X^{(n+2)} + 1$ d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. A binary linear cyclic code $C_{cyc}(n,k)$ has code length $n = 7$ and generator polynomial $g(X) = 1 + X^2 + X^3 + X^4$.

a) Construct the generator matrix for the code.

b) If all the information symbols are 1's, what is the corresponding code vector ? 2 + 3

3. For the linear cyclic code $C_{cyc}(7,4)$ generated by the polynomial $g(X) = 1 + X + X^3$, determine the corresponding generator matrix and then convert it into a systematic generator matrix. 2 + 3

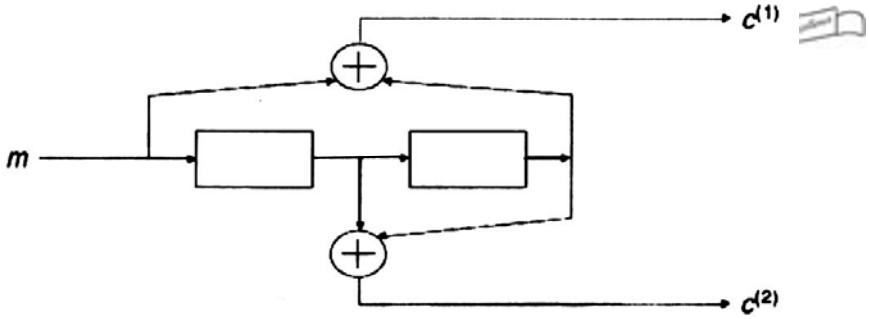
4. The generator matrix of a binary linear block code is given below :

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

a) Write down the parity check equations of the code.

b) Determine the code rate and minimum Hamming distance. 2 + 3

5. Consider the convolutional encoder given below :



a) Determine the generator polynomial.

b) Is this a catastrophic code ? Justify the answer. 2 + 3

6. a) What is Entropy ?

b) Consider a source X which produces five symbols with probabilities $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}$ and $\frac{1}{16}$. Find the source entropy. 2 + 3

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. For a systematic linear block code, the three parity check digits C_4, C_5 and C_6 are given by

$$C_4 = d_1 \oplus d_2 \oplus d_3$$
$$C_5 = d_1 \oplus d_2$$
$$C_6 = d_1 \oplus d_3$$

a) Construct generator matrix.

b) Construct code generator by this matrix.

c) Determine error correcting capability.

d) Prepare a suitable decoding table.

e) Decode the received words 101100. 5×3

8. a) "All cyclic codes must satisfy the property of linearity." Is the statement correct ? Consider that a cyclic code is represented by a polynomial

$$C(x) = C_0 + C_1 x + C_2 x^2 + \ldots + C_{n-1} x^{n-1}$$

Show that a cyclic shift to $C(x)$ is equivalent to $xC(x) \bmod x^{n-1}$.

b) Design a syndrome calculator for a (7, 4) cyclic Hamming code generated by the polynomial $G(p) = p^3 + p + 1$. Calculate the syndrome for $Y = (1\ 0\ 0\ 1\ 1\ 0\ 1)$.

c) The generator polynomial of a (7, 4) cyclic code is $G(p) = p^3 + p + 1$. Find all the code vectors for the code in systematic form. 2 + 3 + 4 + 6

9. a) Explain DES, also explain each round in DES. How triple DES is different from the original DES ?

b) What is a trapdoor one-way function ? What is error propagation in block cipher ?

c) What do you mean by Pretty Good Privacy ? Describe the protocol for quantum key generation.

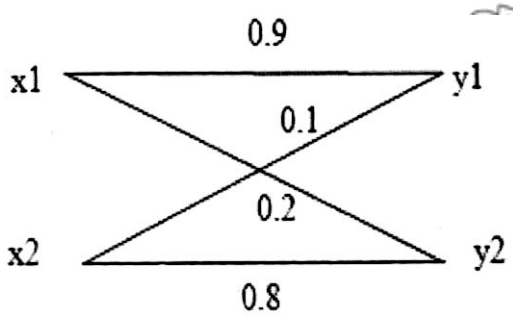
4 + 2 + 2 + 1 + 3 + 3

10. a) A DMS X has five equally likely symbols.

i) Construct Shannon-Fano code for X, and calculate the efficiency of the code.

ii) Repeat for the Huffman code and compare the result.

b) A binary channel is shown in the figure.



i) Find the channel matrix of the channel.

ii) Find $P(y1)$ and $P(y2)$ when $P(x1) = P(x2) = 0 \cdot 5$.

8 + 7

11. Write short notes for the following (any *three*) : $3 \times 5 = 15$

a) BCH code

b) Golay Codes

c) Read Soloman codes

d) Huffman coding

e) Quantum cryptography.

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