CS/B.TECH (ECE) (SUPPLE)/SEM-7/EC-703/09
CODING & INFORMATION THEORY (SEMESTER - 7)

1. .....
Signature of Invigilator

2. .....
Signature of the Officer-in-Charge

Reg. No. | | | | | | | | | | | | | | |

Roll No. of the Candidate | | | | | | | | | | | | | | |

CS/B.TECH (ECE) (SUPPLE)/SEM-7/EC-703/09
ENGINEERING & MANAGEMENT EXAMINATIONS, JULY – 2009
CODING & INFORMATION THEORY (SEMESTER - 7)

Time : 3 Hours] [Full Marks : 70

INSTRUCTIONS TO THE CANDIDATES :

1. This Booklet is a Question-cum-Answer Booklet. The Booklet consists of **32 pages**. The questions of this concerned subject commence from Page No. 3.
2. a) In **Group – A**, Questions are of Multiple Choice type. You have to write the correct choice in the box provided **against each question**.
   b) For **Groups – B** & **C** you have to answer the questions in the space provided marked 'Answer Sheet'. Questions of **Group – B** are Short answer type. Questions of **Group – C** are Long answer type. Write on both sides of the paper.
3. **Fill in your Roll No. in the box** provided as in your Admit Card before answering the questions.
4. Read the instructions given inside carefully before answering.
5. You should not forget to write the corresponding question numbers while answering.
6. Do not write your name or put any special mark in the booklet that may disclose your identity, which will render you liable to disqualification. Any candidate found copying will be subject to Disciplinary Action under the relevant rules.
7. **Use of Mobile Phone and Programmable Calculator is totally prohibited in the examination hall.**
8. You should return the booklet to the invigilator at the end of the examination and should not take any page of this booklet with you outside the examination hall, **which will lead to disqualification**.
9. Rough work, if necessary is to be done in this booklet only and cross it through.

No additional sheets are to be used and no loose paper will be provided

---

FOR OFFICE USE / EVALUATION ONLY

Marks Obtained

	Group – A										Group – B			Group – C				
Question Number																	***Total Marks***	***Examiner's Signature***
Marks Obtained																		

.....
Head-Examiner/Co-Ordinator/Scrutineer

S-53052 (31/07)

DO NOT WRITE ON THIS PAGE

CS/B.TECH (ECE) (SUPPLE)/SEM-7/EC-703/09
CODING & INFORMATION THEORY
SEMESTER - 7

Time : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) Maximum possible entropy of a QPSK system is

a) 2 b) 3

c) 4 d) none of these. ☐

ii) The error detection capability of a (n, k) linear block code is

a) $2^n - 2^k$ b) 2^{n-k}

c) 2^{k-1} d) 2^{n-1} . ☐

iii) In modulo-7 the value of (5 + 11) is

a) 1 b) 2

c) 3 d) 4. ☐

iv) For the Galois field $GF(2^4)$:

(i) This is an extension field of binary field

(ii) Order of the field is 8

(iii) Primitive polynomial to construct this field is equal to $x^4 + x^2 + x + 1$.

Find out the wrong group :

a) (i) and (ii) b) (ii) and (iii)

c) (i) and (iii) d) none of these. ☐

v) An n-tuple v is a code-word in the code generated by G, if and only if,

a) $v \cdot G = 0$ b) $v \cdot G^T = 0$

c) $v \cdot H = 0$ d) $v \cdot H^T = 0$.

vi) For (7, 4) cyclic code choose valid code-words having generator polynomial $g(x) = x^3 + x^2 + 1$ and code-word have a form

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

a) 0100011 b) 1100011

c) 0110011 d) All of these.

vii) In (7, 4) cyclic code with generator polynomial $g(x) = x^3 + x + 1$, the parity-check polynomial is

a) $x^4 + x^2 + 1$

b) $x^4 + x^3 + 1$

c) $x^4 + x^2 + x + 1$

d) $x^4 + x^3 + x + 1$.

viii) The degree of the generator polynomial $g(x)$ of the binary t-error-correcting BCH code of length $2^m - 1$ is at most.

a) t^m

b) m^t

c) mt

d) None of these.

ix) For a t-error correcting Reed -Solomon code of length $(q - 1)$ with symbols from $GF (q)$ the number of code vectors of weight j is

a) $A_j = \binom{q-1}{j} \sum_{i=0}^{j-2t-1} (-1)^i \binom{j}{i} (q^{j-2t-i} - 1)$

b) $A_j = \binom{q-j}{1} \sum_{i=0}^{j-2t-1} (-1)^i \binom{j}{i} (q^{j-2t-i} - 1)$

c) $A_j = \binom{q-1}{j} \sum_{i=0}^{j-2t} (-1)^{i+1} \binom{j}{i} (q^{j-2t} - 1)$

d) none of these. ☐

x) The single error correcting BCH code of length $(2^m - 1)$ is a

a) Convolution code b) Hamming code

c) Reed-Solomon code d) all of these. ☐

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. a) What is Information Rate ?

b) If a channel has channel capacity per symbol = C_s and channel capacity per second = C, then find out the relationship between Information Rate (R) and C.

c) What is the unit of C_s ? 1 + 3 + 1

3. a) What is standard array ? Show the standard array for a (n, k) linear code.

b) What is channel transitional probability ? 2 + 2 + 1

4. a) Write down generator polynomial for (7, 4) cyclic code.

b) Also find systematic and non-systematic code words corresponding to the information word (1100). 1 + 4

5. a) Discuss the scheme of syndrome decoding of the BCH codes.

b) What is the minimum distance of t-error-correcting Reed-Solomon code ? 4 + 1

6. Draw the state diagram for (2, 1, 2) convolutional code and explain. 5

7. a) Write down the rules for encoding in systematic cyclic codes.

b) Consider the following code vectors :

$c_1 = [\ 1 \quad 0 \quad 0 \quad 1 \quad 0\ ]$

$c_2 = [\ 0 \quad 1 \quad 1 \quad 0 \quad 1\ ]$

$c_3 = [\ 1 \quad 1 \quad 0 \quad 0 \quad 1\ ]$

Find $d(c_1, c_2)$, $d(c_2, c_3)$ and $d(c_1, c_3)$. 3 + 2

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

8. a) What is Average Information ?

b) Consider a telegraph source having two symbols dot and dash. The dot duration is 0·2 sec. The dash duration is 3 times the dot duration. The probability of the dot's occurring is twice that of the dash, and the time between symbols is 0·2 sec. Calculate the information rate of the telegraph source.

c) A DMS X has five symbol x_1 , x_2 , x_3 , x_4 and x_5 with probabilities

$P(x_1) = 0{\cdot}4$, $P(x_2) = 0{\cdot}19$, $P(x_3) = 0{\cdot}16$, $P(x_4) = 0{\cdot}15$ and

$P(x_5) = 0{\cdot}1$.

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

ii) Repeat for the Huffman code and compare the results. 2 + 5 + 5 + 3

9. a) Consider a systematic (8, 4) code whose parity-check equations are

$$v_0 = u_1 + u_2 + u_3$$

$$v_1 = u_0 + u_1 + u_2$$

$$v_2 = u_0 + u_1 + u_3$$

$$v_3 = u_0 + u_2 + u_3 \ ,$$

where u_0 , u_1 , u_2 & u_3 are message digits and v_0 , v_1 , v_2 & v_3 are parity-check digits. Find the generator and parity-check matrices for this code. Show analytically that the minimum distance of this code is 4.

b) Design the syndrome circuit for which the parity-generator matrix is given by :

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

c) Prove that, if C be a (n, k) linear code with parity-check matrix H. For each code vector of Hamming weight l, there exist l columns of H such that the vector sum of these l columns is equal to the zero vector. Conversely, if there exist l columns of H whose vector sum is the zero vector, there exists a code vector of Hamming weight l in C. 5 + 5 + 5

10. a) Draw a schematic diagram of an encoder for (7, 4) cyclic code with

$g(x) = X^3 + X + 1$. Explain the operation.

b) For (n, k) cyclic code $C = (C_{n-1} C_{n-2} \ldots\ldots C_1 C_0)$, a system transmitting a code C = (1010011), belonging to the (7, 4) code, incurs the error

e = (1000000).

i) How many bits are in error ?

ii) Find out syndrome polynomial.

iii) Find the received code including error.

iv) Decode the received code to get actual data.

c) How you can check a valid cyclic code ? 7 + 1 + 1 + 1 + 3 + 2

11. a) Let α be a primitive element of the Galois field $GF(2^4)$ such that $1 + \alpha + \alpha^4 = 0$. Generate the triple-error correcting BCH code of length 15.

b) Consider a triple-error correcting Reed-Solomon code with symbols from GF (2^4). The generator polynomial of the code is

$$g(x) = (x + \alpha)(x + \alpha^2)(x + \alpha^3)(x + \alpha^4)(x + \alpha^5)(x + \alpha^6).$$

Let the transmitted code vector is an all-zero vector and the received vector is

$$r = (0\ 0\ 0\ \alpha^7\ 0\ 0\ \alpha^3\ 0\ 0\ 0\ 0\ 0\ \alpha^4\ 0\ 0).$$

Compute the syndrome decoding. 6 + 9

12. a) Draw a (2, 1, 3) binary convolutional encoder and ezplain.

b) Figure shows a (3, 2, 1) binary convolutional encoder. Write down expression of code word after multiplexing. If $U^{(1)} = (101)$ and $U^{(2)} = (110)$ then find V.

dia

c) Draw a linear feed forward shift register with 3 stages and $G_0 = 1$, $G_1 = 0$, $G_2 = 1$, $G_3 = 1$. Determine the output sequence given the input sequence $U = \{1001\}$. 2 + 4 + 4 + 2 + 3

13. a) Discuss RSA algorithm.

b) Encrypt “EXTRANET” using a transposition cipher with the following key :

3	5	2	1	4
1	2	3	4	5

10 + 5

END