R18

Code No: 155BG

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year I Semester Examinations, January/February - 2023
ERROR CORRECTING CODES
(Electronics and Communication Engineering)

Time: 3 Hours **Max. Marks: 75**

Note: i) Question paper consists of Part A, Part B.
ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.
iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

1.a)	What is mean by Forward Error Correction codes?	[2]
b)	Derive the condition for block codes to be a linear code.	[3]
c)	What are the advantages of shortened cyclic codes?	[2]
d)	An (n,k) linear code C is called a cyclic code if every cyclic shift of a code vector in C is also a code vector in C.	[3]
e)	How majority logic decoding differ from other decoding methods of convolutional codes?	[2]
f)	How convolutional codes are used in ARQ systems?	[3]
g)	Define a log prior ration for turbo codes.	[2]
h)	Compare parallel and serial concatenation in turbo codes.	[3]
i)	What are the advantages of Alamouti code?	[2]
j)	How Trellis codes provide diversity?	[3]

PART – B

(50 Marks)

2.a) For a BSC with crossover probability p having input X and output Y, let the probability of the inputs be P(X=0) =q and P(X=1) = 1-q. Find the mutual information?

b) Show that $H(X) \geq H\left(\frac{X}{Y}\right)$. [5+5]

OR

3.a) Prove that the minimum distance of a linear block code is equal to the minimum weight of its nonzero code words.

b) Consider an (n,k)linear code C whose generator matrix G contains no zero column. Arrange all the code vectors of C as rows of a 2^k-by-n array. Show that no column of array contains only zeros. [5+5]

4. Design a decoding circuit for a single-error-correcting and double-error-detecting cyclic Hamming code and explain its working with example. [10]

OR

5.a) For a cyclic code, if an error pattern e(X) is detectable, show that its i^{th} cyclic shift $e^{(i)}(X)$ is also detectable.

b) Let C_1 and C_2 be two cyclic codes of length n which are generated by $g_1(X)$ and $g_2(X)$, respectively. Show that the code polynomials common to both C_1 and C_2 also form a cyclic code C_3. Determine the generator polynomial of C_3. [5+5]

6. Consider the (3, 1, 2) convolutional code with $g^{(1)} = (1\ \ 0\ \ 1\ \ 0)$,
$g^{(2)} = (1\ \ 1\ \ 1\ \ 0)$, $g^{(3)} = (1\ \ 1\ \ 1\ \ 1)$

a) Draw the encoder block diagram
b) Find the generator matrix G
c) Find the code word V corresponding to the information sequence u= (1 1 10 0) using tree diagram? [10]

OR

7. Write Viterbi algorithm and explain how it is used for decoding of convolutional codes. [10]

8.a) Draw the diagram of a log likelihood turbo decoder and explain its working.
b) Show that the log likelihood of the sequency $logp(r) = \log p(r_0^{N-1})$ can be written as $logp(r_0^{N-1}) = log \sum_{all\ valid\ p} \alpha'_N(p) - \sum_{i=o}^{N} A_i$ [5+5]

OR

9. For the parity check matrix

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

a) Construct the Tanner graph for the code.
b) Determine the girth of the minimum-girth cycle.
c) Determine the number of cycles of length 6.
d) Determine a generator matrix for this code.
e) Express the N and M lists describing this parity check matrix. [10]

10.a) How a delay diversity coder may also written as a space-time block code?
b) For the set of space-time codes

$A_1 = \begin{bmatrix} x_1 & x_2^* \\ x_2 & x_1 \end{bmatrix}$ $A_2 = \begin{bmatrix} x_1 & -x_2 \\ x_2 & x_1 \end{bmatrix}$ $A_3 = \begin{bmatrix} x_1 & -x_2 \\ x_2^* & x_1 \end{bmatrix}$ $A_4 = \begin{bmatrix} x_1 & x_2 \\ x_2 & x_1 \end{bmatrix}$

Find diversity order of each code, assuming that the transmitted symbols are selected independently and uniformly from a 40 QAM alphabet and that the receiver has a single antenna. [5+5]

OR

11. Explain the following:
a) BLAST detection
b) Multi-layer detection schemes. [5+5]

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