

**M.TECH/ECE/2ND SEM/ECEN 5202/2015
2015**

**Error Control Coding
(ECEN 5202)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

***Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.***

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

**Group - A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 x 1=10**
- (i) A discreet memoryless source with entropy H and average word length L has the following boundary relation
(a) $L \geq H$ (b) $L < H$ (c) $L \geq e^H$ (d) $L < H^2$.
- (ii) Shannon limit obtained from Shannon's capacity theorem is
(a) 2 dB (b) 10 dB (c) -1.6 dB (d) -5 dB.
- (iii) Memoryless channels are called
(a) random error channels (b) burst error channels
(c) none of these (d) combined error channels.
- (iv) If a linear block code is a error correcting then it must atleast
(a) satisfy the hamming bound (b) over satisfy the hamming bound
(c) dissatisfy the hamming bound (d) none of these.
- (v) "The hamming distance between two n -tuples V and W is equal to the hamming weight of the sum of V & W ."- is
(a) true (b) false
(c) not a property of LBC (d) none of these.
- (vi) Common decoding technique for convolution code word is known as
(a) Syndrome decoding (b) Hamming decoding
(c) Viterbi decoding (d) Huffman decoding.
- (vii) For generation of (n, k) Cyclic code, number of stages in a linear Feed Back Shift Register (LFSR) is given by
(a) n^2 (b) k^2 (c) $n-k$ (d) $n+k$.
- (viii) For very large message sequence the code rate of the convolution depends upon
(a) shift register size (b) number of modulo-2 adders
(c) number of bits of message sequence (d) initial stage of shift register.

- (ix) $p(x)=1+x+x^3$ is a primitive polynomial over $GF(2)$, the element α^4 in this field has a polynomial representation as
(a) $\alpha+1$ (b) $\alpha^2+\alpha$ (c) $1+\alpha^2$ (d) 1.
- (x) Modulo-5 multiplication of two integers 4 and 3 in Galois field is
(a) 1 (b) 2 (c) 3 (d) 4.

Group - B

- 2.(a) Explain the term Entropy in Information Theory. Plot Entropy of a Binary memory less source with source probability and interpret the nature of variation of Entropy with source probability.
- (b) Following source symbols are emitted from with corresponding probabilities.
- | Symbol | probability |
|--------|-------------|
| S_0 | 0.4 |
| S_1 | 0.2 |
| S_2 | 0.2 |
| S_3 | 0.1 |
| S_4 | 0.1 |

Find code word following Huffman coding. Find also the amount of entropy.

6+6=12

- 3.(a) What is meant by primitive polynomial? Under what condition does an irreducible polynomial become a primitive polynomial?
- (b) A polynomial over binary field expressed as $1+x+x^2+x^3+x^4$ divides $x^{15}+1$ and x^5+1 with remainder equal to zero in each case. Is this polynomial a primitive polynomial? Give reasons for your answer.
- (c) Polynomial $f(d) = 1+x$ is defined over $GF(2)$ and the same polynomial is also defined over $GF(3)$. Find the expression for $[f(x)]^2$ in each case .

(2+3)+3+4=12

Group - C

- 4.(a) Explain the following terms in connection with Block coding
i) Parity check matrix
ii) Generator matrix
iii) Syndrome
- (b) A (6,3) symmetric block code data bits $(d_1 d_2 d_3)$ and check bits $(c_1 c_2 c_3)$ are related by
 $c_1 = d_1 \oplus d_2$ $c_2 = d_1 \oplus d_3$ $c_3 = d_2 \oplus d_3$
Find i) Generator matrix ii) Possible code words
Calculate syndrome for a received sequence 101000.

6+6=12

- 5.(a) Explain the characteristics of a cyclic code. Express a cyclic code in terms of a polynomial. What is the degree of polynomial? A (7, 4) cyclic code has a generator polynomial x^3+x^2+1 . Find the cyclic codeword for a data word 1010.
- (b) Draw the Hardware diagram using logic elements for encoding of (7,3) cyclic code. Explain the operation of the logic circuit.

6+6=12

Group - D

- 6.(a) For the convolutional encoder as shown in the Fig. 1 draw the code tree up to 5 branches and trace the path for generation of convolutional code word for input 10011. Write down the codeword.

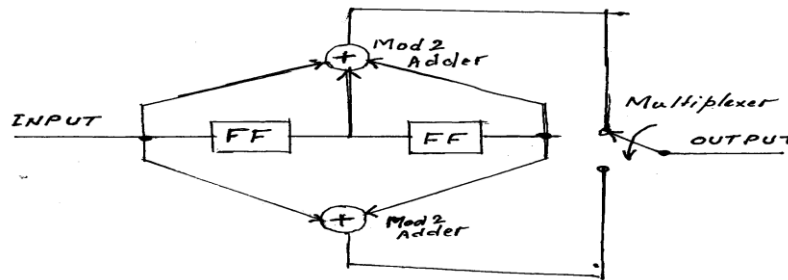


Fig.1

- (b) Describe the principle of Viterbi algorithm for decoding a convolutionally coded word. What is the metric for comparison of received code and transmitted code?

6+6=12

- 7.(a) Refer to Fig. 1, determine the convolutional code at the output of the encoder of Fig.1 for input message 10011 following time domain approach. Justify the name convolutional coding as revealed from time domain approach.

- (b) Write a note on Reed Solomon code.

(5+2)+5=12

Group - E

- 8.(a) What drawbacks would appear in a digital communication system when channel coding and modulation are performed separately? How are these drawbacks compensated in Trellis Coded Modulation (TCM)? Explain the basic principle of TCM.

- (b) Illustrate the signal mapping by set partitioning of 8PSK signal constellation as suggested by Ungerboeck. Indicate the minimum Euclidean distance in each subset.

6+6=12

- 9.(a) Describe the function of recursive systematic Convolutional Coder employed for Turbo Coding. Explain how Turbo coded output bits are generated by parallel operation in the three branches of the Turbo encoder.

- (b) What kind of decoding algorithm is employed in turbo decoding?

(4+6)+2=12