Reg No.:_______________ Name:__________________________

**APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(S), MAY2019

**Course Code: EC401**

**Course Name: INFORMATION THEORY & CODING**

Max. Marks: 100 Duration: 3 Hours

**PART A**

***Answer any two full questions, each carries 15 marks.*** Marks

1 a) Define the term: Amount of information. Find out the information conveyed by one of the two equally probable messages. (3)

b) Joint probability matrix of a discrete channel is given by, (12)

$$P(X,Y)=\begin{matrix} 0.05 & 0.05 & 0.02 & 0.05 \\ 0.15 & 0.16 & 0.01 & 0.09 \\ 0.12 & 0.03 & 0.02 & 0.05 \\ 0.01 & 0.12 & 0.01 & 0.06 \end{matrix}$$

Compute marginal, conditional and joint entropies and verify their relation.

2 a) Given an AWGN channel with 5 K Hz bandwidth and the noise power spectral density $\eta/2 = 10^{-9}$ W/Hz. The signal power required at the receiver is 1mW.Calculate the capacity of this channel. (5)

b) Given a telegraph source having two symbols, dot and dash. The dot duration is 0.6 sec. The dash duration is half the dot duration. The probability of the dots occurrence is thrice that of the dash and the time between symbols is 0.1 sec. Calculate the information rate of the telegraph source. (6)

c) What is the joint entropy H(X, Y), and what would it be if the random variables X and Y were independent? (4)

3 a) State and establish Kraft's inequality. (7)

b) Determine the Huffman coding for the following message with their probabilities given $p(x_1)=0.05$, $p(x_2)=0.15$, $p(x_3)=0.2$, $p(x_4)=0.05$, $p(x_5)=0.15$, $p(x_6)=0.3$, $p(x_7)=0.1$. Find the efficiency and redundancy of the code. (8)

**PART B**

***Answer any two full questions, each carries 15 marks.***

4 a) Draw the bandwidth –SNR trade off graph and explain. (7)

b) The parity bits of a (7,4) linear systematic block code are generated by (8)

$c_5 = d_1+d_3+d_4$

$c_6=d_1+d_2+d_3$

$c_7=d_2+d_3+d_4$

(+ sign denotes modulo-2 addition)

where $d_1$, $d_2$, $d_3$ and $d_4$ are message bits and $c_5, c_6, c_7$ are parity bits. Find generator matrix G and parity check matrix H for this code. Draw the encoder circuit.

5 a) Find the capacity of a channel with infinite bandwidth. Discuss Shannon's limit. (7)

b) The parity matrix of a (6, 3) linear systematic block code is given below. (8)

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

Find all the possible code vectors.

a) Find out the minimum distance of the code.

b) How many errors can be detected and corrected by this code?

6 a) Explain the properties of a field. Cite any two examples. (5)

b) Alphanumeric data are entered into a computer from a remote terminal through a voice grade telephone channel. The channel has a bandwidth of 3.4 KHz and output signal to noise power ratio of 20 dB. The terminal has a total of 128 symbols which may be assumed to occur with equal probability and that the successive transmissions are statistically independent. (10)

a) Calculate the channel capacity.

b) Calculate the maximum symbol rate for which error free transmission over the channel is possible.

## PART C

***Answer any two full questions, each carries 20 marks.***

7 Draw a (2, 1, 2) convolutional encoder with the feedback polynomials as $g_1(X)=1+X+X^2$ and $g_2(X)= 1+X^2$. Draw Trellis and find the output sequence for input sequence [1 0 0 1 1]. Do Viterbi decoding on this trellis for the received sequence {01, 10, 10, 11, 01, 01, 11} and obtain the estimate of the transmitted sequence and the message sequence. (20)

8 a) A channel encoder uses a (7, 4) linear systematic cyclic code in the systematic form, generator polynomial being $X^3 + X + 1$. Determine the correct codeword transmitted if the received word is (8)

(i) 1011011 (ii) 1101111

b) Draw a (3,2,1) convolutional encoder with impulse responses given as $g_1^{(1)}=[1,1]$, $g_1^{(2)}=[1,0]$, $g_1^{(3)}=[1,0]$, $g_2^{(1)}=[0,1]$, $g_2^{(2)}=[1,1]$, $g_2^{(3)}=[0,0]$. (7)

c) Mention the parameters of BCH codes. (5)

9 a) Discuss the procedure for generation of a systematic cyclic code. Draw and explain the systematic cyclic encoder circuit for a (15, 9) cyclic code with generator polynomial $g(X)= 1+ X^3+ X^4+ X^5+ X^6$. (8)

b) Draw a (2,1,2) convolutional encoder with the feedback polynomials as $g_1(X)=1+X+X^2$ and $g_2(X)= 1+X^2$. Draw the code tree and trace output for input sequence 10011. (7)

c) What are Reed Solomon Codes? Discuss properties. (5)

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