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SEVENTH SEMESTER | B.TECH-EVENING (ECE)

END-SEMESTER EXAMINATION (SUPPLEMENTARY) FEBRUARY-2019

CEC-401 Information Theory and Coding

Time: 3:00 Hours Max. Marks: 40

Note: *Q1 is compulsory.
**Answer any 08 questions out of remaining 10 questions i.e. Q2 to Q11.
***Assume suitable missing data, if any.

1. Answer all the following Compulsory questions:

   (a) State the relation between the generator polynomial and the parity check polynomial of an (n,k) cyclic linear code. (1.5)

   (b) What is the physical meaning of the mutual information of a channel? State the properties of I (X;Y), the mutual information of the discrete random variable X and Y. (1.5)

   (c) Differentiate source coding theorem with channel coding theorem. (1.5)

   (d) In a linear block code, how are the parity check bits produced? (1.5)

   (e) Explain the Markov source with an example. (2.0)

2. Channel matrix for a channel is given as follows: $P\left(\frac{Y}{X}\right)=\begin{bmatrix}0.8 & 0.2 & 0\\ 0 & 1 & 0\\ 0 & 0.3 & 0.7\end{bmatrix}$

   Also, the input probabilities of the channel are: $P(X)=[0.3 \quad 0.4 \quad 0.3]$

   Determine (i) $H(X)$, (ii) $H(Y)$, (iii) $H(X,Y)$, (iv) $H(X|Y)$, (v) $H(Y|X)$

   (0.5+0.5+1+1+1=4.0)

3. A discreate memoryless source produces symbols $x_i, i=1,2,3,4,5$ with the following probabilities:

   $$p(x_1)=0.4, p(x_2)=0.19, p(x_3)=0.16, p(x_4)=0.15, p(x_5)=0.1$$

   Design a Huffman code for the above source. Find the efficiency of code. (2+2=4.0)

4. Consider a DMS X with symbols x_i and corresponding probabilities $P(x_i)=P_i, i=1,2,...,m$. Let n_i be the length of the code word for x_i such that

   $$\log_2\left(\frac{1}{P_i}\right)\le n_i \le \log_2\left(\frac{1}{P_i}\right)+1$$

   Show that this relationship satisfies the Kraft inequality and find the bound for it. (3+1=4.0)

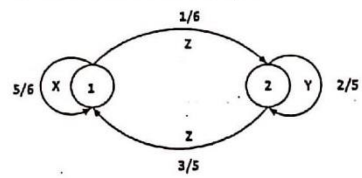
5. Derive the following signal energy to noise power spectral density ratio for the Shannon's limit for additive white Gaussian noise (AWGN) channel. (4.0)

   $$\frac{E_b}{\eta}=-1.6dB$$

6. Encode the following binary sequence using LZW coding. Assume that binary symbols 0 and 1 are already there in the codebook. (4)

111010011000101...

7. For the Markoff source shown in figure below, Find (i) State probabilities, (ii) State entropies, and (iii) Source entropy, (iv) G1, G2. Also show that G1, G2 > H. (1+1+1+1=4.0)



8. For a (6, 3) systematic linear block code, the three parity-check bits C_4, C_5 and C_6 are formed from the following equations. $C_4 = d_1 \oplus d_3$, $C_5 = d_1 \oplus d_2 \oplus d_3$, $C_6 = d_1 \oplus d_2$ (1+1+2=4.0)
   (i) Determine the generator matrix of the code.
   (ii) List out all the code vectors of the code.
   (iii) Suppose that the received word is 010111. Decode this received word by finding the location of the error and transmitted data bits.

9. Consider the (7,4) systematic cyclic code with generator polynomial $g(x) = (1 + x + x^3)$ and if the received vector is 0110010, then find the following: (2+2=4.0)
   (i) Transmitted data word
   (ii) Syndrome calculation circuit.

10. Consider a (7,4) cyclic code with generator polynomial $g(x) = (1 + x + x^2)$. Obtain the code polynomial in a systematic form for the following data sequences: (2+2=4.0)
    (i) 1010
    (ii) 1100

11. Let us consider the (n=2,k=1, m=2) convolution coder with $g^{(1)} = (1 \quad 1 \quad 1)$ and $g^{(2)} = (1 \quad 0 \quad 1)$ where n : no. of output lines, k : no of input lines and m: no. of memory elements. Find the following:
    (i) Codewords for the data sequence (10011) using time-domain approach
    (ii) Codewords for the data sequence (10011) using transform domain approach. (2+2=4.0)

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