Visvesvaraya Technological University, Belagavi
MODEL QUESTION PAPER

5th Semester, B.E (CBCS) EC/TC
Course: 15EC54 - Information Theory and Coding

Note: (i) Answer Five full questions selecting any one full question from each Module.
(ii) Question on a topic of a Module may appear in either its 1st or 2nd question.

Time:3 Hrs **Max. Marks: 80**

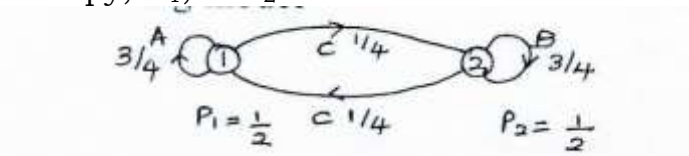
<table>
<tr><td colspan="4"><u>MODULE - 1</u></td></tr>
<tr><td>1</td><td>a.</td><td>Define Self Information, Entropy and Rate of Information</td><td>3</td></tr>
<tr><td></td><td>b.</td><td>A Binary Source produces symbols 0 and 1 with probability P and 1-P. Determine Entropy of the source. Sketch the variation of Entropy with P and comment on the result.</td><td>5</td></tr>
<tr><td></td><td>c.</td><td>Prove that Entropy function attains maximum value when the symbols are emitted with equal probability.</td><td>8</td></tr>
<tr><td colspan="4">OR</td></tr>
<tr><td>2</td><td>a.</td><td>For the Markov Source shown in Fig. Q 2.a., find the source Entropy, G_1, & G_2
 

Fig. Q 2.a.</td><td>12</td></tr>
<tr><td></td><td>b.</td><td>In a Facsimile picture transmission of pictures, there is about 3.25 M-pixels per frame. For a good reproduction, 15 brightness levels are necessary. Assuming that all the levels are equally likely to occur, find the rate of transmission if one picture is transmitted in every 3 minutes.</td><td>4</td></tr>
<tr><td colspan="4"><u>MODULE - 2</u></td></tr>
<tr><td>3</td><td>a.</td><td>Apply Shannon encoding algorithm and generate binary codes for the set of symbols given in table below. Also find efficiency.
<table>
<tr><td>Sym</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr>
<tr><td>P</td><td>9/32</td><td>9/32</td><td>3/32</td><td>3/32</td><td>3/32</td><td>3/32</td><td>2/32</td></tr>
</table></td><td>8</td></tr>
<tr><td></td><td>b.</td><td>Using Shannon Fano Algorithm, encode the following set of symbols and find the efficiency:
<table>
<tr><td>Sym</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr>
<tr><td>P</td><td>1/2</td><td>1/4</td><td>1/8</td><td>1/16</td><td>1/32</td><td>1/64</td><td>1/64</td></tr>
</table></td><td>5</td></tr>
<tr><td></td><td>c.</td><td>Write the decision tree for the following set of codes and check for KMI property.
<table>
<tr><td>A</td><td>1</td></tr>
<tr><td>B</td><td>10</td></tr>
<tr><td>C</td><td>110</td></tr>
<tr><td>D</td><td>1110</td></tr>
<tr><td>E</td><td>1111</td></tr>
</table></td><td>3</td></tr>
</table>

		OR	
4	a.	A discrete memory less source has an alphabet of seven symbols with probabilities as given below: Sym A B C D E F G P 0.25 0.25 0.125 0.125 0.125 0.0625 0.0625 Compute Huffman Code for the set of symbols shown above by moving combined symbols as high as possible and as low as possible. Find efficiency and variance.	8
	b.	Write a note on Arithmetic Coding	4
	c.	Design a ternary code for the set of symbols with probabilities as given below: Sym A B C D E F P 1/3 1/4 1/8 1/8 1/12 1/12	4
		MODULE - 3	
5	a.	The Joint probability matrix of a channel is given. Compute H(x), H(y), H(xy), H(x/y) and H(y/x) $P(xy) = \begin{bmatrix} 0.05 & 0 & 0.2 & 0.05 \\ 0 & 0.1 & 0.1 & 0 \\ 0 & 0 & 0.2 & 0.1 \\ 0.05 & 0.05 & 0 & 0.1 \end{bmatrix}$	05
	b.	A Binary Symmetric Channel has the following Joint probability matrix. Compute Mutual Information, Data transmission Rate and Channel Capacity if r_s = 100sym/sec $P(xy) = \begin{bmatrix} \frac{35}{72} & \frac{25}{72} \\ \frac{5}{72} & \frac{7}{72} \end{bmatrix}$	06
	c.	Derive an expression for the Data Transmission Rate of Binary Erasure Channel.	05
		OR	
6	a.	An analog source has a bandwidth of 4KHz. The signal is sampled at 2.5 times the Nyquist Rate and each sample is quantized into 256 equally likely levels. Assume that the successive samples are statistically independent. Find the information rate of the source. Can the output of this source be transmitted without error over an analog channel of Bandwidth 50Khz and S/N = 20db. If the output of the source is to be transmitted without error over an analog channel having S/N = 10, compute the bandwidth required.	06
	b.	Consider a Binary Symmetric Channel whose channel matrix is given by $P(y/x) = \begin{bmatrix} 0.7 & 0.3 \\ 0.4 & 0.6 \end{bmatrix}$. Find Channel Capacity.	05
	c.	Write a note on Differential Entropy	05
		MODULE - 4	

7	a.	Define Hamming Weight, Hamming Distance, Minimum Distance of Linear Block code and Systematic Linear Block Code	04
	b.	For a Linear Block Code the syndrome is given by: $S_1 = r_1 + r_2 + r_3 + r_5$, $S_2 = r_1 + r_2 + r_4 + r_6$, $S_3 = r_1 + r_3 + r_4 + r_7$ (i) Find Generator Matrix (ii) Find Parity Check Matrix (ii) Draw the Encoder and Decoder Circuit (iii) How many errors can be detected and corrected?	12
		OR	
8	a.	A (15,11) Cyclic Code is generated using $g(x) = 1+x+x^4$. Design an encoder and illustrate the encoding procedure with the message vector [11001101011] by listing the state of the register assuming the right most bit as the earliest bit.	08
	b.	A (7,4) Cyclic Code has the generator polynomial $g(x) = 1+x+x^4$. Write the syndrome calculation circuit and verify the circuit for the message polynomial $d(x) = 1+x^3$	08
		MODULE - 5	
9	a.	Write short notes on Golay Codes	04
	b.	Consider the (3,1,2) Convolutional encoder with $g^{(1)} = (110)$, $g^{(2)} = (101)$ and $g^{(3)} = (111)$. (i) Find Constraint Length. (ii) Find Rate Efficiency. (iii) Draw the encoder diagram (iv) Find the generator Matrix (v) Find the codeword for the message sequence (11101) using matrix approach and frequency domain approach	12
10.	a.	For a (2,1,3) Convolutional encoder with $g^{(1)} = (1101)$, $g^{(2)} = (1011)$, (i) Write the state transition table (ii) Draw the code tree (iii) Draw the Trellis Diagram (iv) Find the encoded output for the message (11101) by traversing the code tree.	10
	b.	Explain Viterbi Decoding algorithm	06

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