Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRONICS ENGINEERING (SENSE)

BECE313L: Information Theory and Coding

PROBLEM SHEET-2
Probability Based Source Coding

Instructions:

1. Total Marks: 15
2. Weightage of marks in grades : 4%
3. Last Date for Submission: 16.09.2024
4. All answers must be handwritten
5. Late submission are not allowed
6. Submission must be through teams

Address each problem with thorough analysis and detailed solutions.

<table>
<tr><th>Q.No</th><th>Question</th><th>Marks</th></tr>
<tr><td>1</td><td>Determine, which of the following codes shown in the table below are prefix codes. Also draw the decision diagram for the prefix codes
<table>
<tr><th>Code A</th><th>Code B</th><th>Code C</th><th>Code D</th></tr>
<tr><td>00</td><td>11</td><td>01</td><td>101</td></tr>
<tr><td>10</td><td>101</td><td>001</td><td>1101</td></tr>
<tr><td>110</td><td>011</td><td>000</td><td>1010</td></tr>
<tr><td>0110</td><td>110</td><td>100</td><td>1100</td></tr>
<tr><td>010</td><td>1110</td><td>110</td><td>1111</td></tr>
</table></td><td>1</td></tr>
<tr><td>2</td><td>Find the smallest value of r such that prefix codes can be constructed for the following code length requirements $W = (1, 2, 3, 4, 5)$ for the corresponding $L = (1, 2, 3, 4, 5)$</td><td>1</td></tr>
<tr><td>3</td><td>The following coding scheme depicted in table has been used to encode the sequence. Draw the decision tree
<table>
<tr><th>Source Symbols</th><th>Code A</th><th>Code B</th></tr>
<tr><td>T</td><td>00000</td><td>-</td></tr>
<tr><td>S</td><td>00001</td><td>0000</td></tr>
<tr><td>I</td><td>0001</td><td>001</td></tr>
<tr><td>H</td><td>01</td><td>01</td></tr>
<tr><td>A</td><td>1</td><td>1</td></tr>
</table>
If the receiver receives the following bitstream:

<code>0000101001000100000010000100000100000101001001000100000</code>
<code>1100000001010100100100000011000000010000100000010000010</code>

Decode the information.</td><td>1</td></tr>
</table>

4	An information source produces a sequence of independent symbols having following probabilities. Construct the binary and ternary code using Huffman encoding Procedure and find its efficiency. A B C D E F G 1/4 1/16 1/8 1/16 1/8 1/8 1/4	1
5	An information source produces a sequence of independent symbols having following probabilities. Construct the quarternary Huffman code and find its efficiency. A B C D E F G H 0.22 0.20 0.18 0.15 0.10 0.08 0.05 0.02	1
6	Consider a discrete memoryless source with $S = (X, Y, Z)$ with state probabilities $P = (0.7, 0.15, 0.15)$ for its output. • Apply Huffman encoding algorithm to find the codewords in binary. Find the source efficiency and redundancy • Consider the second-order extension of the source. Compute the codewords for this extended source and also find its efficiency	2
7	Find the codewords and determine the average codeword length while encoding the following sentence using Huffman coding **Hope fuels dreams, urging us onward, even when shadows lengthen, doubts arise. Believe, persevere, for within struggles, strength blossoms**	1
8	Consider the following source $S = \{A, B, C, D, E, F\}$ with following probabilities $P = \{0.10, 0.15.0.25, 0.35, 0.08, 0.07\}$. Find the code words using Shannon-Fano Algorithm, Determine the Coding Efficiency and Redundancy	1
9	Consider a D-adic distribution of source symbols A,B,C,D with probabilities $\frac{1}{2^2}, \frac{1}{2}, \frac{1}{2^3}, \frac{1}{2^3}$. Construct the codewords usign Shannon-Fano-Elais Coding algorithm, Determine the Coding Efficiency and Redundancy	1
10	Consider a discrete memoryless source with S=(X,Y,Z) with the corresponding probabilities P=(0.5,0.3,0.2). • Find the codewords for the symbols using Shannon's algorithm. Also find the source Efficiency and Redundancy • Consider the second order extension of the source. Recompute the codewords and the efficiency	1

11	Consider the following Source $S = \{A, B, C, D, E, F\}$ with probabilities $P = \{0.4, 0.2, 0.2, 0.1, 0.08, 0.02\}$ Find the codewords and efficiency by using following algorithms. • Shannon's first encoding algorithm • Shannon-Fano Coding Algorithm • Shannon-Fano-Elias Coding Algorithm Compare their efficiencies and conclude the best algorithm with your inferences	2
12	Consider a discrete memoryless source with $S = \{X, Y, Z\}$ with respective probabilities $P = \{0.6, 0.2, 0.2\}$ Find the codeword for the message **'Y X Z X Y'** using arithemtic coding.	1
13	A Consider a discrete memoryless source with $S = \{X, Y, Z\}$ with respective probabilities $P = \{0.6, 0.2, 0.2\}$ is used for transmission. The received arithmetic codeword is 0.70464. Determine the message transmitted.	1