

International Islamic University Chittagong (IIUC)

Department of Electronic and Telecommunication Engineering

Midterm Examination

Program: **B.sc (Engg.)**

Course Code: **ETE – 3505**

Total Marks: **30**

Semester: **Autumn 2022**

Course Title: **Information theory and coding**

Time: **1 Hours 30 Minutes**

(i) Answer all the questions. The figures in the right-hand margin indicate full marks.						
(ii) Course Outcomes (COs) and Bloom's Levels are mentioned in additional Columns.						
Course Outcomes (COs) of the Questions						
CLO1	Familiarization with the various fields/trends of communications like Information theory, error detection and error correction related to radio and telecommunication.					
CLO2	Analysis different types of error control code properties for secure and error free efficient communications.					
Bloom's Levels of the Questions						
Letter Symbols	R	U	Ap	An	E	C
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

Q1.	a)	A zero memory source contains $X=\{x_1, x_2, x_3, x_4\}$ with $P(X)=\{1/2,1/4,1/8,1/8\}$ i) Determine <i>entropy</i> of the source. ii) Determine second extension of the source. Show that $H(X^2)=2H(X)$	CLO2	E	6																								
	b)	Consider the three codes listed below: <table border="1"><thead><tr><th>Source Symbol</th><th>Probability of Occurrence</th><th>Code I</th><th>Code II</th><th>Code III</th></tr></thead><tbody><tr><td>s_0</td><td>0.5</td><td>0</td><td>0</td><td>0</td></tr><tr><td>s_1</td><td>0.25</td><td>1</td><td>10</td><td>01</td></tr><tr><td>s_2</td><td>0.125</td><td>00</td><td>110</td><td>011</td></tr><tr><td>s_3</td><td>0.125</td><td>11</td><td>111</td><td>0111</td></tr></tbody></table> i) Identify which one is the prefix code and construct its decision trees; ii) “Meeting <i>Kraft-McMillan Inequality</i> does not give the guarantee of being a prefix code”-justify the statement considering all three codes.	Source Symbol	Probability of Occurrence	Code I	Code II	Code III	s_0	0.5	0	0	0	s_1	0.25	1	10	01	s_2	0.125	00	110	011	s_3	0.125	11	111	0111	CLO2	An
Source Symbol	Probability of Occurrence	Code I	Code II	Code III																									
s_0	0.5	0	0	0																									
s_1	0.25	1	10	01																									
s_2	0.125	00	110	011																									
s_3	0.125	11	111	0111																									

Q2.	Determine Shannon-Fano code. Calculate efficiency & redundancy of Shannon-Fano coding. <table><tr><td>Message</td><td>Probability</td></tr><tr><td>M₁</td><td>1/2</td></tr><tr><td>M₂</td><td>1/4</td></tr><tr><td>M₃</td><td>1/8</td></tr><tr><td>M₄</td><td>1/16</td></tr><tr><td>M₅</td><td>1/32</td></tr><tr><td>M₆</td><td>1/64</td></tr><tr><td>M₇</td><td>1/128</td></tr><tr><td>M₈</td><td>1/128</td></tr></table>	Message	Probability	M ₁	1/2	M ₂	1/4	M ₃	1/8	M ₄	1/16	M ₅	1/32	M ₆	1/64	M ₇	1/128	M ₈	1/128	CLO2	E	10
Message	Probability																					
M ₁	1/2																					
M ₂	1/4																					
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M ₅	1/32																					
M ₆	1/64																					
M ₇	1/128																					
M ₈	1/128																					
Q3.	A Discrete Memoryless Source has an alphabet of eight symbols whose probabilities of occurrence are as described here: <table><tr><td>Symbol</td><td>Probability</td></tr><tr><td>s₀</td><td>0.25</td></tr><tr><td>s₁</td><td>0.20</td></tr><tr><td>s₂</td><td>0.15</td></tr><tr><td>s₃</td><td>0.12</td></tr><tr><td>s₄</td><td>0.10</td></tr><tr><td>s₅</td><td>0.08</td></tr><tr><td>s₆</td><td>0.05</td></tr><tr><td>s₇</td><td>0.05</td></tr></table> (i) Use the Huffman encoding procedure to determine a binary code for the source output. (ii) Determine the average number of binary digits per source symbol. (iii) Determine the entropy of the source and compare it with average number.	Symbol	Probability	s ₀	0.25	s ₁	0.20	s ₂	0.15	s ₃	0.12	s ₄	0.10	s ₅	0.08	s ₆	0.05	s ₇	0.05	CLO2	E	4+3+3
Symbol	Probability																					
s ₀	0.25																					
s ₁	0.20																					
s ₂	0.15																					
s ₃	0.12																					
s ₄	0.10																					
s ₅	0.08																					
s ₆	0.05																					
s ₇	0.05																					
OR																						
Q3.	A Discrete Memoryless Source has an alphabet of eight ^{six} symbols whose probabilities of occurrence are as described here:	CLO2	E	4+3+3																		

Symbol	Probability
s_0	0.30
s_1	0.25
s_2	0.20
s_3	0.12
s_4	0.08
s_5	0.05

(i) Use the Huffman encoding procedure to determine a binary code for the source output.

(ii) Determine the average number of binary digits per source symbol.

(iii) Determine the entropy of the source and compare it with average number.