CMR INSTITUTE OF TECHNOLOGY

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Internal Assesment Test – I

Sub:	Information Theory and Coding		Sec	ECE 5A,B,C & D ;TCE A			Code:	15EC54
Date:	11 / 09 / 2018	Duration:	90 mins	Max Marks:	50	Sem: V	Branch:	ECE/TCE

	SCHEME EVALUATION	Marks	OBE CO	RBT
1	Define *self-information*, *entropy* and *information rate*. Consider transmission of pictures in a black and white television, there are about 3.25 $Megapixels/frame$. 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 frame is transmitted in every $3sec$.	10	C504.1	L1
	Definition of each terms	1X3=3		
	No. of different frames = $15^{3.25X10^6}$	1		
	Entropy $H(s) = 12.697 \text{ X } 10^6 \; bits/frame$	2		
	Symbol rate $r_s = \frac{1}{3} \; frame/sec$	2		
	Average information rate $R_s = 4.2323 \text{ X } 10^6 \; bits/sec$	2		
2	Prove that $H(S) \leq log_2 q$ bits/symbol, where q is the number of symbols in the source alphabet.	6	C504.1	L2
	Entropy is non negative	1		
	Entropy is symmetric	1		
	Entropy has boundaries	1		
	Entropy is additive	1		
	Proof for $H(S) \leq log_2 q$	6		
3	The state diagram of a Markov source is shown in the fig. 3. Show that $G_1 \geq G_2 \geq H$.	10	C504.1	L3

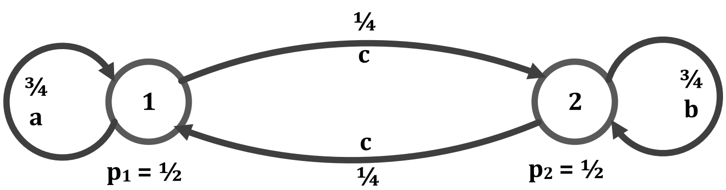

Fig. 3

		Marks
	$H_1 = 0.8113 \; bits/symbol$	1
	$H_2 = 0.8113 \; bits/symbol$	1
	$H = 0.8113 \; bits/symbol$	1
	Code tree taking state 1 as initial state	1
	Code tree taking state 2 as initial state	1
	$G_1 = 1.56 \; bits/symbol$	2
	$G_2 = 1.28 \; bits/symbol$	2
	$G_1 \geq G_2 \geq H$	1

		Marks	CO	RBT
4	Apply Shannon's encoding technique for the message, $S = \{a, b, c, d, e\}$, where each letter is associated with probabilities $P = \left\{\frac{1}{4}, \frac{3}{16}, \frac{1}{8}, \frac{1}{16}, \frac{3}{8}\right\}$ respectively. Calculate the code redundancy.	5	C504.2	L2
	Obtaining the Codes	5		

Symbols	Prob	CW	l_i
e	$\frac{6}{16}$	00	2
a	$\frac{4}{16}$	01	2

b	$\frac{3}{16}$	101	3
c	$\frac{2}{16}$	110	3
D	$\frac{1}{16}$	1111	4

Average length, $L = 2.4375\ bits/sym$ 2

Entropy, $H(S) = 2.1085\ bits/sym$ 2

Efficiency, $\eta_s = 0.865$

Redundancy, $R_{\eta s} = 0.135$

$\eta_s = 86.5\%$; $R_{\eta s} = 13.5\%$ 1

5 Given the symbols $S = \{y_1, y_2, y_3, y_4, y_5, y_6\}$ with respective probabilities $P = \{0.02, 0.08, 0.1, 0.2, 0.2, 0.4\}$, construct a binary code by applying Shannon-Fano encoding procedure. Determine the code efficiency and redundancy. Draw the code tree for the same. 10 C504.2 L3

Obtaining the codes 6

Symbols	Prob	CW	l_i
y_6	0.4	00	2
y_5	0.2	01	2
y_4	0.2	10	2
y_3	0.1	110	3
y_2	0.08	1110	4
y_1	0.02	1111	4

Average length, $L = 2.194\ bits/sym$ 1

Entropy, $H(S) = 2.3\ bits/sym$ 1

Efficiency, $\eta_s = 0.9539$

Redundancy, $R_{\eta s} = 0.0461$

$\eta_s = 95.39\%$; $R_{\eta s} = 4.61\%$ 1

Code tree 1

6 Consider a zero memory source with S = {!, @, #, $, %,^, &} appearing with probabilities P = {0.4, 0.2, 0.1, 0.1, 0.1, 0.06, 0.04} respectively. Apply Huffman coding and determine the code efficiency and redundancy. 10 C504.2 L2

Obtaining the code 4

Symbols	Prob	CW	l_i
!	0.4	00	2
@	0.2	11	2
#	0.1	011	3
$	0.1	100	3
%	0.1	101	3
^	0.06	0100	4

s_5	0.04	0101	4

	Average length, $L = 2.5$ bits/symbol	1		
	Entropy, $H = 2.419$ bits/symbol	2		
	Code efficiency $= 96.76\%$	2		
	Code redundancy $= 3.24\%$	1		
7	Consider a source $S = \{a, e, t\}$ appearing with probabilities $P = \{0.2, 0.5, 0.3\}$. Encode ***tea*** using arithmetic coding and generate a tag.	10	C504.2	L3
	Obtaining the code	9		
	Generating the tag; $\boldsymbol{tag = 0.635}$	1		