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Maneng 461
Assignment 1

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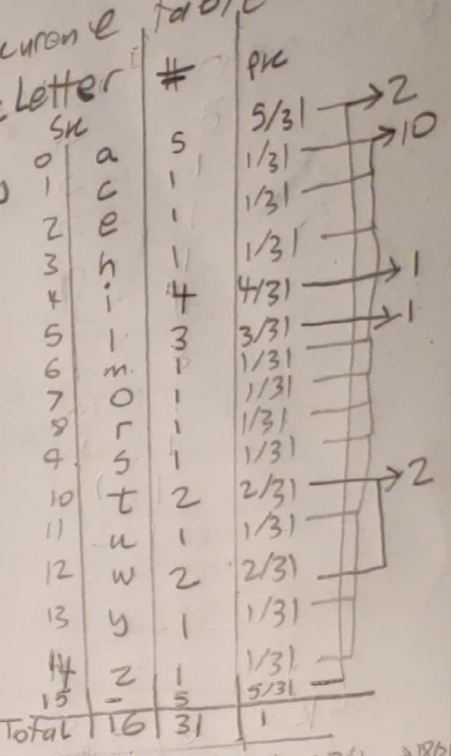
① Source code: rami_wail_shoula_at_zewail_city ② Occurance table :-

Sy	Letter	#	Prc
0	a	5	5/31
1	c	1	1/31
2	e	1	1/31
3	h	1	1/31
4	i	4	4/31
5	l	3	3/31
6	m	1	1/31
7	o	1	1/31
8	r	1	1/31
9	s	1	1/31
10	t	2	2/31
11	u	1	1/31
12	w	2	2/31
13	y	1	1/31
14	z	1	1/31
15	-	5	5/31
Total		31	1



② Huffman coding ③ spaces counted

④ Total Letters (with spaces) = 31 ⑤ - is space

⑥ Arrangement probability high to low + if same probability Then arrangement of table (top to bottom) :-

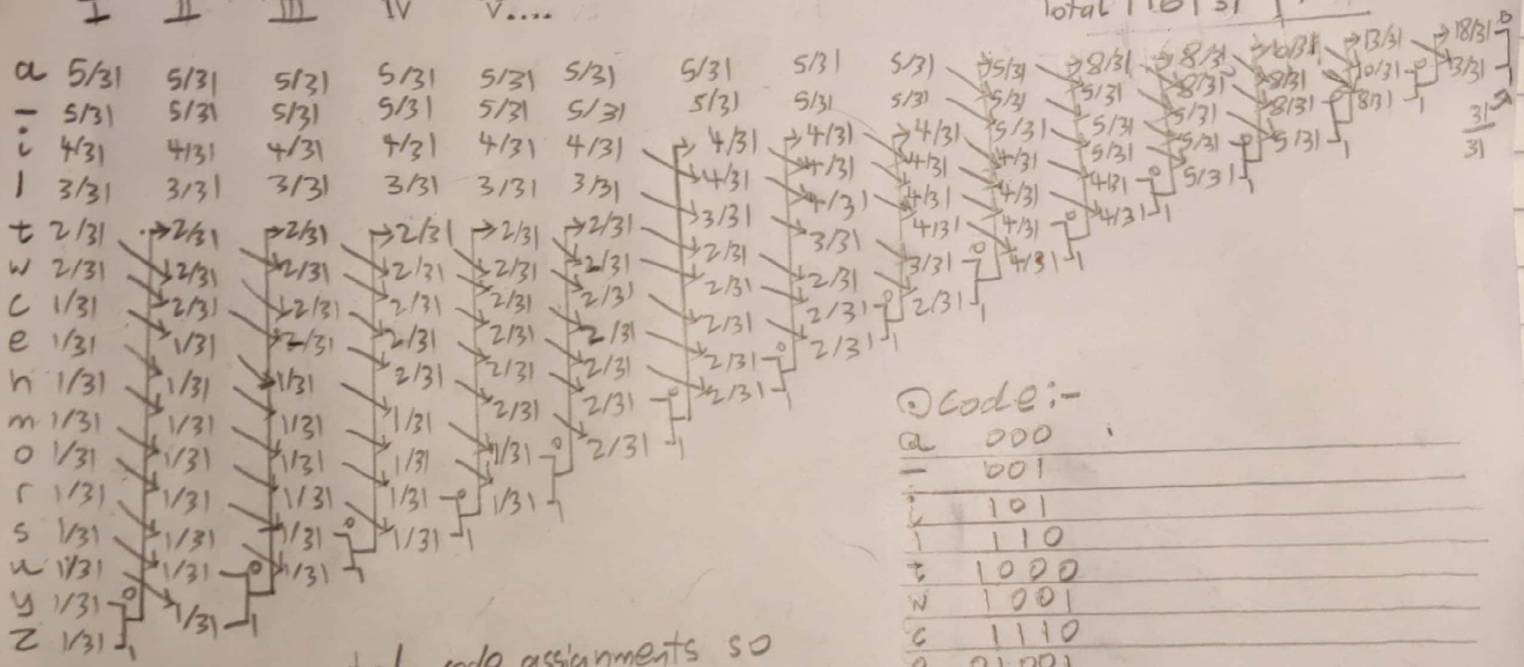
a - i l t w c e h m o r s u y z [K = 16]

⑦ $H(S) = \sum_{k=0}^{K-1} P_k \log_2\left(\frac{1}{P_k}\right)$ ∵ K = 16 ∴ $H(S) = \sum_{k=0}^{15} P_k \log_2\left(\frac{1}{P_k}\right)$

$$\therefore H(S) = \frac{1}{31}\left\{2(5)\log_2\left(\frac{31}{5}\right) + 10(1)\log_2(31) + 4(1)\log_2\left(\frac{31}{4}\right) + 3(1)\log_2\left(\frac{31}{3}\right) + 2(2)\log_2\left(\frac{31}{2}\right)\right\}$$

$$\boxed{\therefore H(S) = 3.6647 \text{ bits (Entropy)}}$$

⑧ Huffman coding :-



⑨ Code :-

a	000
-	001
i	101
l	110
t	1000
w	1001
c	1110
e	01001
h	01010
m	01011
o	01010
r	01011
s	01100
u	01101
y	01110
z	01111

⑩ Note :- There are repeated code assignments so there is a mistake in the coding (I tried my best to trace this)

⑪ Average code length :- $\bar{L} = \sum_{k=0}^{K-1} P_k L_k$

$$\therefore \bar{L} = \frac{1}{31}\left\{2(5)(3) + 4(3) + 3(3) + 2(2)(4) + 4 + 9(5)\right\}$$

$$\therefore \boxed{\bar{L} = \frac{116}{31} = 3.7419} \quad \therefore \bar{L} > H(S) \text{ satisfied}$$

$L_{min} = 3$ ∴ efficiency $= \eta = \frac{L_{min}}{\bar{L}}$

$$\therefore \boxed{\eta = \frac{3}{\left[\frac{116}{31}\right]} = \frac{93}{116} \simeq 0.802}$$

efficiency $\mu = \frac{H(S)}{\bar{L}} = \frac{3.6647}{3.7419}$

$$\therefore \boxed{\mu = 0.979}$$