Exam _ Correction

Exo 1 : I) QPSK modulation $\Rightarrow$ 4 levels $\Rightarrow L = 4$

$\Rightarrow n = \log_2 L = 2$ (symbole length) $\boxed{n = 2 \text{ bits}}$

. The bitrate : $D = 4\ G\,bps = 4.10^9\ bps$

a) the baud rate : $R = \frac{D}{n} = \frac{4}{2} = 2\,G\ baud \Rightarrow \boxed{2.10^9\ baud}$ 0,5 pt

b) $T_b = \frac{1}{D} = \frac{1}{4.10^9} = \underline{0{,}25.10^{-9}s} = \boxed{0{,}25\ nanos}$ 0,25 pts

c) $T_s = \frac{1}{R} = \frac{1}{2.10^9} = \underline{0{,}5.10^{-9}s} \Rightarrow \boxed{0{,}5\ nanos}$ 0,25 pts

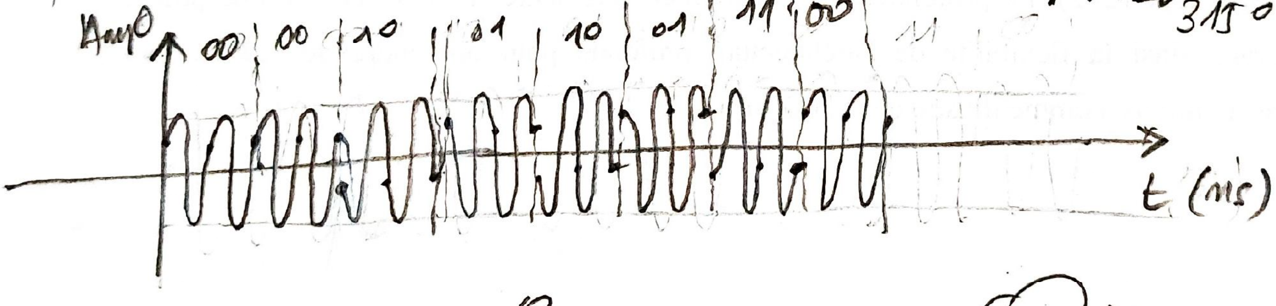
d) $Bw = ?$ $\quad Bw = (1+d).R$ $\quad / d = 0$ (ideal system)

$Bw = (1+0).2.10^9 = \boxed{2.\ GHz}$ 0,5 pt

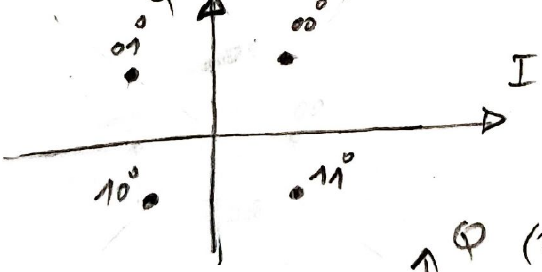
e) the message is : 00 00 10 01 10 01 11 00

| 00 → 45°
| 01 → 135°
| 10 → 225°
| 11 → 315°

0,5 pts

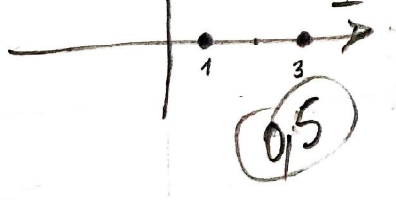


f)



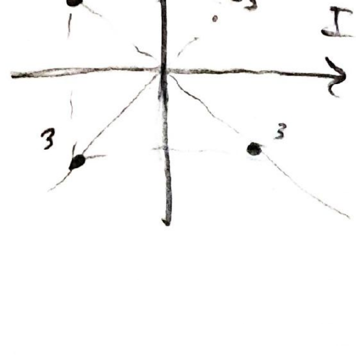
0,5 pts

II)



0,5

0,5



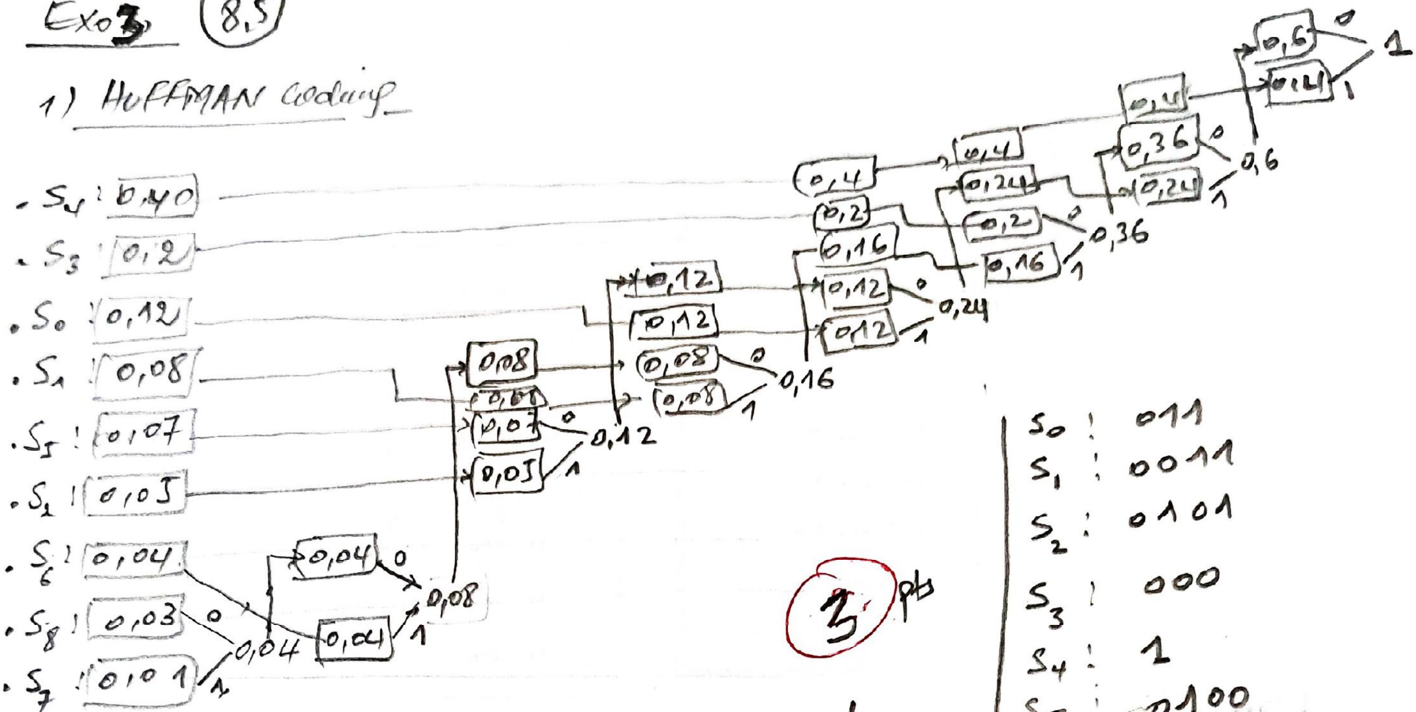
0,5

0,5

Exam - Correction

Exo 3 (8,5)

1) HUFFMAN coding



S_0	011
S_1	0011
S_2	0101
S_3	000
S_4	1
S_5	0100
S_6	00101
S_7	001001
S_8	001000

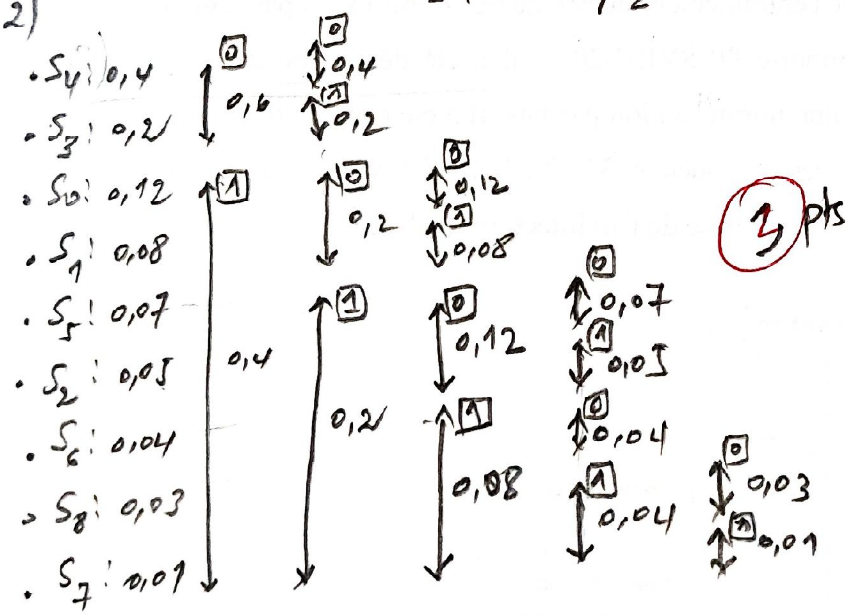
3 pts

S_4 : 1 / S_3 : 000 / S_0 : 011 / S_1 : 0011 /

S_6 : 00101 / S_8 : 001000 / S_7 : 001001

S_5 : 0100 / S_2 : 0101

2)



3 pts

S_4	00
S_3	10
S_0	001
S_1	1101
S_5	0011
S_2	1101
S_6	0111
S_8	01111
S_7	11111

S_0	100
S_1	101
S_2	1101
S_3	10
S_4	00
S_5	0011
S_6	0111
S_7	11111
S_8	11110

3) HUFFMAN is prefix, but Shannon Fano is not prefix. 1 pt

4) $H(x) = \sum_i P_i(x) \cdot \lg_2 \frac{1}{P_i(x)} = -\sum_{i=0}^{8} P_i(x) \cdot \lg_2 P_i(x)$

$= -\left[0{,}12 \lg_2 0{,}12 + 0{,}08 \lg_2 0{,}08 + 0{,}05 \lg_2 0{,}05 + 0{,}2 \lg_2 0{,}2 + 0{,}4 \lg_2 0{,}4 + 0{,}07 \lg_2 0{,}07 + 0{,}04 \lg_2 0{,}04 + 0{,}01 \lg_2 0{,}01 + 0{,}03 \lg_2 0{,}03\right] = 2{,}54$ bits

$\boxed{H(x) = 2{,}54}$ bits 1 pt

5) $\eta = \dfrac{H(x)}{\bar{L}}$, $\bar{L} = \sum_i l_i P_i(x)$

. Huffman: $\bar{L}_H = \sum_{i=0}^{8} l_i P_i = [3 \cdot 0{,}12 + 4\times 0{,}08 + 4\times 0{,}05 + 3\times 0{,}2 + 1\cdot 0{,}4 + 4\cdot 0{,}07 + 5\times 0{,}04 + 6\times 0{,}01 + 6\cdot 0{,}03]$

$\boxed{\bar{L}_H = 2{,}60}$ bits

. Shan-Fano: $\bar{L}_S = [3\times 0{,}12 + 3\times 0{,}08 + 4\times 0{,}05 + 2\times 0{,}2 + 2\times 0{,}4 + 4\times 0{,}07 + 4\cdot 0{,}04 + 5\cdot 0{,}01 + 5\times 0{,}03]$

$\boxed{\bar{L}_S = 2{,}64}$ bits

$\Rightarrow \eta_H = \dfrac{H(x)}{\bar{L}_H} = \dfrac{2{,}54}{2{,}60} = 0{,}977\% \rightarrow \boxed{\eta_H = 97{,}7\%}$ 1 pt

$\eta_S = \dfrac{H(x)}{\bar{L}_S} = \dfrac{2{,}54}{2{,}64} = 0{,}962 \rightarrow \boxed{\eta_S = 96{,}2\%}$ 1 pt

6) **Remark:** Huffman coding is most effective than Shannon-Fano 1 pt

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6 pts

Exo 2: The received message v': 101110

Code: Hamming (7,4) $\rightarrow$ v': $\overset{(7)}{0}\overset{(6)}{1}\overset{(5)}{0}\overset{(4)}{1}\overset{(3)}{1}\overset{(2)}{1}\overset{(1)}{0}$ | $r=3$, $k=4$, $n=7$

* **control bits method** *

1) $C_2' C_1' C_0'$

$\cdot\ C_2' = P(v_1', v_3', v_5', v_7') = P(0,1,0,0) = 1 \neq 0$

$\Rightarrow v'$ is wrong. 3 pts

$\cdot\ C_1' = P(v_2', v_3', v_6', v_7') = P(1,1,1,0) = 1$

$\cdot\ C_2' = P(v_4', v_5', v_6', v_7') = P(1,0,1,0) = 0$

2) The bit having error is : (011) $\rightarrow$ 3rd bit

v_3' : $0101\overset{\times}{1}10$ 1 pt

3) The correct $v' \rightarrow v_c'$: 0101010 1 pt

4) $m = 0100$ 2 pts

= **Syndrom method** =

1) $v' \times H^T = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}$; $v' \times H^T = 001 \neq 000$

$\Rightarrow v'$: wrong.

2) Position : S $\rightarrow$ 3rd ligne

$\Rightarrow$ 3rd Position $0101\overset{\times}{1}10$

3) $v_c' \rightarrow 0101010$

4) $m = 0100$

(not included)