L2 2025/2026

Exam Solution – telecom & Netw 1

Ex01 : $v = 1111101$

(I)

1) BASK $\Rightarrow$ 02 levels $\Rightarrow L = 2 \Rightarrow \eta = \log_2 L = 1$ (nbre bits/symb)

The baud rate $R = \frac{D}{\eta} = \frac{3}{1} = 3$ Mbaud $= 3.10^6$ baud

2) $T_b = \frac{1}{D} = \frac{1}{3.10^6} = 0{,}33.10^{-6}\,s = 0{,}33\,\mu s$.

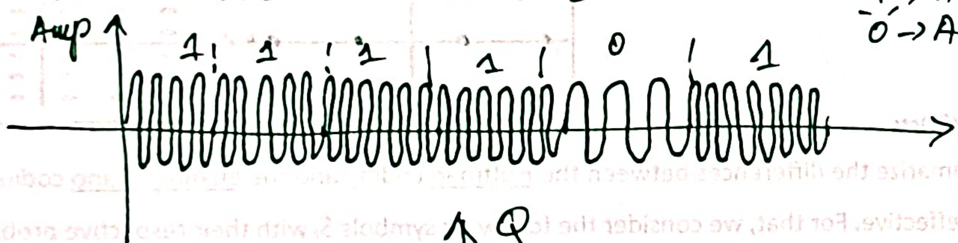
3) $T_s = T_b = 0{,}33\,\mu s$.

4) $B_W = (1+\alpha).R$, As $\alpha = 0$ (ideal case)

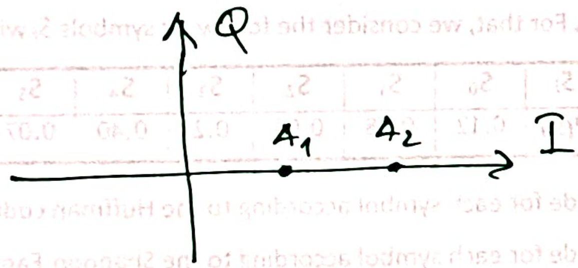
$\Rightarrow B_W = 3.10^6\,HZ = 3\,MHZ$

$1 \to A_1$ / $0 \to A_2$ | $A_2 > A_1$

5)



6)



(II)

(1) : 8 PSK

(2) : 2ASK or BPSK

(3) : 4 QAM

(4) : 32 QAM

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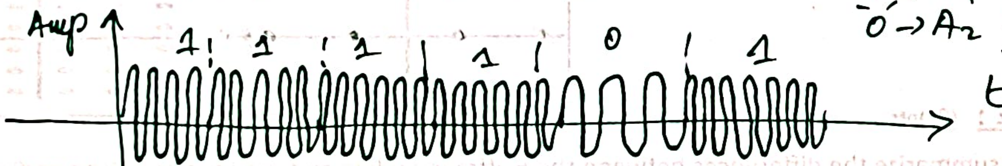

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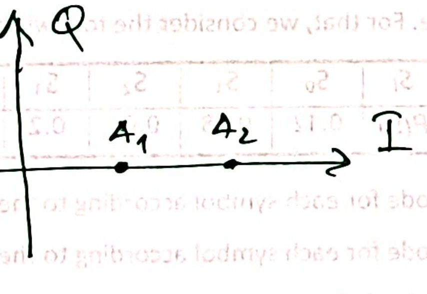

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* Exo2 → 1) Huffman encoding + tree. Diagram

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

→ 2) Shannon-Fano coding + tree diagram

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

→ 3) Huffman is prefix
Shannon-Fano is not prefix

→ 4) $H(x) = -\sum_i P_i(x) \cdot \log_2 P_i(x) = 2,54$ bits

→ 5) $\eta = \frac{H(x)}{\bar{L}}$ / $\bar{L} = \sum_i l_i P_i(x) =$

* Huffman → $\eta_H = \frac{H(x)}{\bar{L}_H}$, where $\bar{L}_H = 2,60$ bits.

* Shannon-Fano → $\eta_s = \frac{H(x)}{\bar{L}_s}$, where $\bar{L}_s = 2,64$ bits

⇒ $\eta_H = 0,977 = 97,7\%$

$\eta_s = 0,962 = 96,2\%$

→ Remark! Huffman encoder is more effitient than Shannon-Fanno coder

Ex 3

1 $m = 11010101$

$H(15,11)$, to employ $H(15,11) \to m = \overset{11}{0}\overset{10}{0}\overset{9}{0}\overset{8}{1}\overset{7}{1}\overset{6}{0}\overset{5}{1}\overset{4}{0}\overset{3}{1}\overset{2}{0}\overset{1}{1}$ (11 bits)

$r = 15 - 11 = 4$ bits $\to C_3, C_2, C_1, C_0$.

* $C_0 = v_2$

v_{15}	v_{14}	v_{13}	v_{12}	v_{11}	v_{10}	v_9	v_8	v_7	v_6	v_5	v_4	v_3	v_2	v_1
m_{11}	m_{10}	m_9	m_8	m_7	m_6	m_5	C_3	m_4	m_3	m_2	C_2	m_1	C_1	C_0
0	0	0	1	1	0	1	C_3	0	1	0	C_2	1	C_1	C_0

* $C_0 = v_3 \oplus v_5 \oplus v_7 \oplus v_9 \oplus v_{11} \oplus v_{13} \oplus v_{15} = 1$
* $C_1 = v_3 \oplus v_6 \oplus v_7 \oplus v_{10} \oplus v_{11} \oplus v_{14} \oplus v_{15} = 1$
* $C_2 = v_5 \oplus v_6 \oplus v_7 \oplus v_{12} \oplus v_{13} \oplus v_{14} \oplus v_{15} = 0$
* $C_3 = v_9 \oplus v_{10} \oplus v_{11} \oplus v_{12} \oplus v_{13} \oplus v_{14} \oplus v_{15} = 1$

$\Rightarrow v = 0001101\overset{C_3}{1}010\overset{C_2}{0}1\overset{C_1}{1}1$

$\to$ Generator Matrix: G (11×15)

$$G = \begin{bmatrix}
1&0&0&0&0&0&0&1&0&0&0&1&0&1&1\\
0&1&0&0&0&0&0&1&0&0&0&1&0&1&0\\
0&0&1&0&0&0&0&1&0&0&0&1&0&0&1\\
0&0&0&1&0&0&0&1&0&0&0&1&0&0&0\\
0&0&0&0&1&0&0&1&0&0&0&0&0&1&1\\
0&0&0&0&0&1&0&1&0&0&0&0&0&1&0\\
0&0&0&0&0&0&1&1&0&0&0&0&0&0&1\\
0&0&0&0&0&0&0&0&1&0&0&1&0&0&0\\
0&0&0&0&0&0&0&0&0&1&0&1&0&1&1\\
0&0&0&0&0&0&0&0&0&0&1&1&0&1&0\\
0&0&0&0&0&0&0&0&0&0&0&0&1&0&1
\end{bmatrix}$$