ELEX 4340 FINAL EXAM SOLUTIONS

TERM 201430

Q.1

$\xi X_i \Rightarrow 0x\ 0\ 3\ B\ E$

$= 0000\ 0011\ 1011\ 1110$

$0000\ 0yyy\ yyxx\ xxxx$ (from Table 3-6)

encoding: $1100\ 1110\ 1011\ 1110$

C E B E

UTF-8 encoding requires **2 bytes**: **0xce**, **0xbe**

Q.2

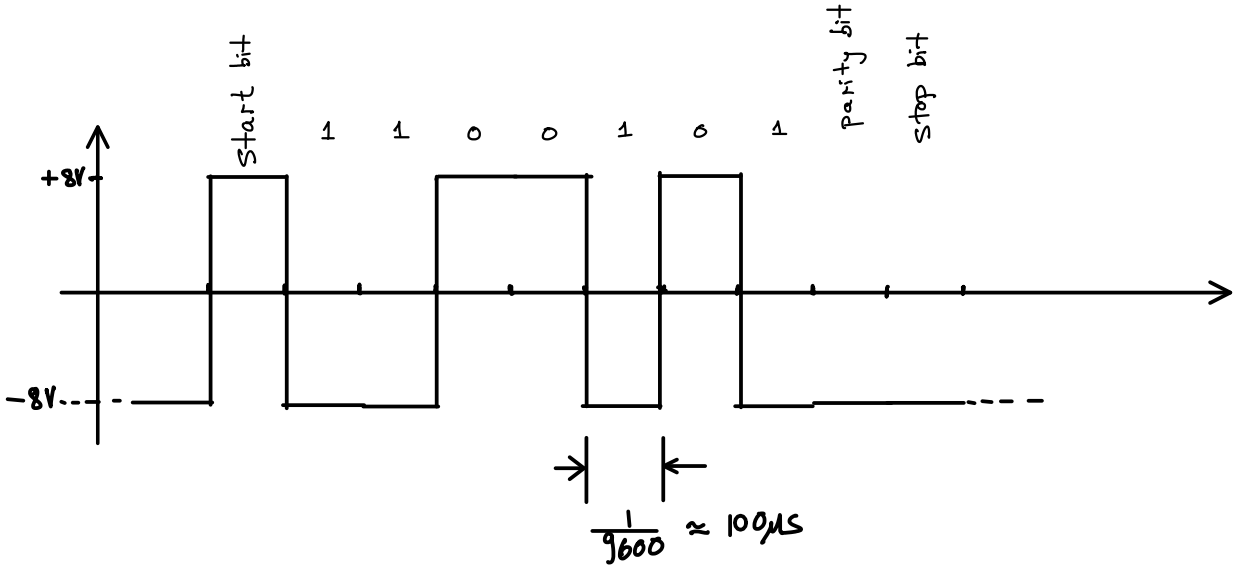
$0x53 \Rightarrow 0101\ 0011$

bit reversed: $1100\ 1010$ ← omit MS bit

polarity: L L H H L H L L

number of 1's = 4 (even)

∴ parity bit must be 1 (L) (4+1=5 is odd)



Q.3

$P_T = 50\,kW = 50 \times 10^3\,W$

$f = 100\,MHz = 100 \times 10^6\,Hz \quad \lambda = \frac{c}{f} = \frac{3 \times 10^8}{10^8} = 3m$

$G_T = G_R = 0\,dB = 1$

$d = 15\,km = 15 \times 10^3\,m$

$$P_R = P_T\, G_T\, G_R \left(\frac{\lambda}{4\pi d}\right)^2$$

$$= 50 \times 10^3 \cdot 1 \cdot 1 \cdot \left(\frac{3}{4\pi \times 15 \times 10^3}\right)^2 = 12 \times 10^{-6}\,W$$

$$= 12 \times 10^{-3}\,mW$$

in dBm: $P_R = 10 \log\left(12 \times 10^{-3}\right) =$ **-19 dBm**

Q.4

$-6\,dB = 10^{\left(\frac{-6}{20}\right)} \approx \frac{1}{2}$ ($|H(f)|$ is a voltage, not a power ratio)

From graph, the -6dB bandwidth is **1 MHz.**

Channel response extends to 2 MHz.

For no ISI the minimum bandwidth is the -6 dB bandwidth, 1 MHz.

Excess bandwidth is $2\,MHz - 1\,MHz = 1\,MHz$

$$\alpha = \frac{1\,MHz\ (excess)}{1\,MHz\ (minimum)} = \boxed{1} \quad (100\,\%)$$

Maximum symbol rate = 2X -6 dB bandwidth = **2 MHz**

Q.5

start flag: 0 1 1 1 1 1 1 0

1 2 3 4 5 0 1 0 0

1 1 1 1 1 0 1 0 0

↑ stuffed bit

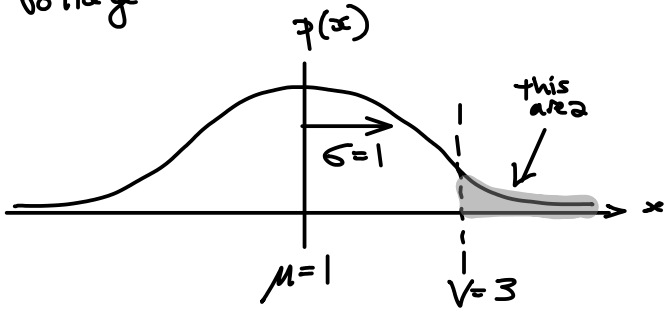
end flag: 0 1 1 1 1 1 1 0

Q.6

$\sigma = 1\,V$ = rms voltage, for zero-mean (AC coupling)

$\mu = 1\,V$ = average voltage

threshold $V = 3V$

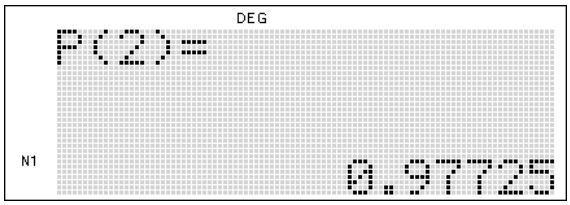


$P(x > V) = 1 - P(x < V)$

$$t = \frac{V-\mu}{\sigma} = \frac{3-1}{1} = 2$$

$P(x<3V) = P(2) \simeq 0.977$

$P(x>3V) = 1 - 0.977 =$ **2.3 %**



Q.7

(a) 16 codewords can encode $\log_2 16 =$ **4 bits** $= k$

if bits/codeword $= n = 7$, rate $= \frac{k}{n} =$ **$\frac{4}{7}$**

(b) for highest throughput

- with long delay: go-back-N OR selective repeat
- with high error rate: **selective repeat**

(c) for $d_{min} = 4$

detectable errors = $d_{min} - 1 = \boxed{3}$

correctable errors = $\left\lfloor \frac{d_{min}-1}{2} \right\rfloor = \left\lfloor \frac{4-1}{2} \right\rfloor = \lfloor 1.5 \rfloor = \boxed{1}$

(d) only **10 Base T** uses Manchester

(100Base T uses MLT-3, 1000BaseT uses 4 levels)

(e) for CBR data the channel can be partitioned in a fixed manner using either **TDMA or FDMA**

for busty data channel should be allocated to users as needed ⇒ **CSMA**

(f) the netmask for a /17 network has 17 leading 1's & ∴ 15 trailing zeros:

255.255.128.0

8 + 8 + 1 = 17