ELEX 3525 FINAL EXAM SOLUTIONS

201310

Q.1

(a) $f_{s/2} = 3\text{kHz}$ $\quad f_s = \underline{6}$ ksymbols/second (kHz)

(b) 3 bits/symbol × 6×10^3 symbols/second = 18 kb/s

(c) $C = B \log_2(1 + S/N)$

$B = 3\text{kHz}$
$N = 0\text{dBm} = 1\text{mW}$

$C \geqslant 18\text{kb/s} = 18 \times 10^3$

solve for S:

$$\frac{C}{B} = \log_2(1 + S/N)$$

$$2^{C/B} - 1 = S/N$$

$$S = N\left(2^{C/B} - 1\right) = 1 \times \left(2^{\frac{18}{3}} - 1\right) = 1 \times \left(2^6 - 1\right)$$

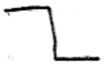
$$S = 1 \times (63) = \underline{63\text{mW}}$$

in dBm: $10 \log_{10}(63) = 18\text{dBm}$.

Q.2

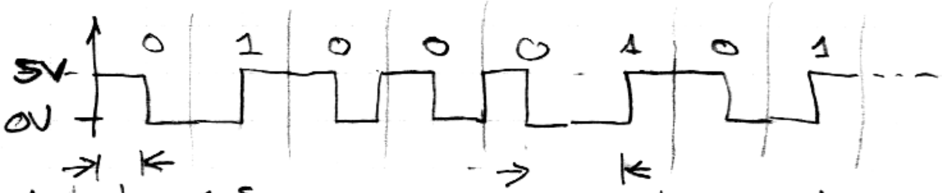
MSB first, LSB last

E = 0X45 = 0 1 0 0 0 1 0 1

Manchester: 0 = 

1 = 

(a)



baud period $= \frac{1}{10 \times 10^6}$ s $= 0.1\mu s$ $\quad$ max = 2 × baud period.

Q.2 (ctd.)

(b) minimum time $= \frac{1}{\text{baud rate}} = \frac{1}{10 \times 10^6} = 0.1\mu s.$

min time $= 2 \times \text{min} = 0.2\mu s$

(c) bit rate $= \frac{1}{\text{bit duration}}$

1 bit is 2 transition $= 2 \times 0.1\mu s = 0.2\mu s.$

bit rate $= \frac{1}{0.2\mu s} = 5 Mb/s$

Q.3

divide $M(x)$ by $G(x)$ & check remainder.

```
           0 1 0 1
       -------------
 1101 ) 0 1 1 1 0 0 1
        0 0 0 0 ↓
        -------
          1 1 1 0
          1 1 0 1 ↓
          -------
          0 1 1 0
          0 0 0 0 ↓
          -------
            1 1 0 1
            1 1 0 1
            -------
                  0  ← remainder is zero ⇒ no errors.
```

$G(x) = 1x^3 + 1x^2 + 0x + 1$
$= 1101$

Q.4

$f_b = 10 \times 10^6 \ b/s$

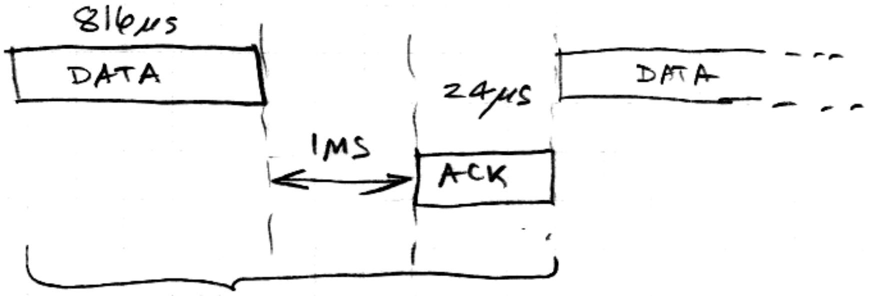
(a) data frame $= (1000 + 20) \times 8 = $ 8160 bits

ack frame $= 30 \times 8 = 240$ bits

data: $\frac{8160}{10 \times 10^6} = 816\mu s = 0.816ms$ / ack: $\frac{240}{10 \times 10^6} = 24\mu s. = 0.024\mu s$

Q.4 (ctd)

(b)



duration = 816 + 1000 + 24 = 1840 μs.

$$\text{throughput} = \frac{\text{data bits}}{\text{duration}} = \frac{8000}{1840 \times 10^{-6}} = \underline{4{,}35 \text{ Mb/s}}$$

(← data only)

(c) – goback-N
OR
– selective-repeat

Q.5

(a) A has 4 possible values
B " " "

total of 4×4 = 16 possible signals (symbols).

modulation is 16-QAM

(b) $\# \text{bits} = \log_2(\#\text{symbols}) = \log_2(16) = \underline{4 \text{ bits/symbol}}$

Q.6

(a) 4 codewords ⇒ $\log_2(4) = 2$ bits transmitted per codeword

(b) n = # of bits / codeword = 5 (given)
k = # of data bits = 2 (above).

this is a (5, 2) code.

(c) y receive 11000

differences are:

```
  00110
  11000
  -----
  ✓✓✓✓      d=4

  01101
  11000
  -----
  10101     d=3

  10010
  11000
  -----
  01010     d=2

  11001
  11000
  -----
  00001     d=1  ← minimum distance
```

would choose codeword of minimum distance:
11001

since distance is 1, 1 bit error would be corrected.

Q.7

1: (a) RS is effective mainly for bursty error channels

2: (b) LDPC codes can achieve close to capacity, but are not simple to implement.

Q. 7 (ctd)

3: (b) and (c)

either DCE to DCE
or DTE to DTE

4: (a) and (b)

typically both (a) and (c) are used,

cannot connect to conventional logic output (possibility of conflict).

5: (b) ⇒ less interference & radiation.

- cable costs are higher (2 wires)
- propagation delay is function of ε_r

(32 min)