ECE 363 Spring 2026 Assignment 2 Solutions

Q.1

A B ESC ESC C C ESC ESC ESC FLAG

ESC FLAG D

Q.2

0110 0111 1100 1111 0111 1101

0110 0111 1101 1110 1111 11

Q.3

it is possible
suppose the original text contains the bit
sequence 01111110

after bit stuffing this is

011111010

if the second 0 is lost due to a
transmission error what is received is

01111110

which the receiver sees as end of frame

- it then looks just before the end of the frame for the checksum and verifies it

- if the checksum is 16 bits say CRC-16, there is a 1 in 2^{16} chance of it being correct, leading to an incorrect frame being accepted

the longer the checksum, the lower the probability of an error getting through undetected but this probability is never zero

Q.4 Hamming code

$d = 1010\ 1111$ $\quad m = 8$

$(m+r+1) \le 2^r$ is satisfied by $r=4$

so $n = 12$

the check bits are in positions 1, 2, 4, 8

the codeword is

$c = \_\ \_\ 1\ \_\ 010\ \_\ 1111$

check 1 is $3+5+7+9+11$
$1+0+0+1+1 = 1$

check 2 is $3+6+7+10+11$
$1+1+0+1+1 = 0$

check 4 is $5+6+7+12$
$0+1+0+1 = 0$

check 8 is $9+10+11+12$
$1+1+1+1 = 0$

c = 1010 0100 1111

Q.5 0111 0101 1101 received

check 1 = $1+3+5+7+9+11$
$0+1+0+0+1+0 = 0$

check 2 = $2+3+6+7+10+11$
$1+1+1+0+1+0 = 0$

check 4 = $4+5+6+7+12$
$1+0+1+0+1 = 1$

check 8 is $8+9+10+11+12$
$1+1+1+0+1=0$

the syndrome is $S=0100$

so the error is in position 4

$c = 0110\ 0101\ 1101$

to obtain the message remove the check bits

$d = 1010\ 1101$

Q. 6 bit string 11100110

(a) $M(x) = x^7+x^6+x^5+x^2+x$ $G(x) = x^4+x^3+1$

$r=4$

$M(x)x^4 = x^{11}+x^{10}+x^9+x^6+x^5$

divide this by $G(x)$

```
                10110110
11001 | 111001100000
        11001
        -----
          10111
          11001
          -----
           11100
           11001
           -----
             10100
             11001
             -----
              11010
              11001
              -----
               0110
```

$R(x) = x^2 + x$

$T(x) = x^r M(x) + R(x)$

$= x^{11} + x^{10} + x^9 + x^6 + x^5 + x^2 + x$

1110 0110 0110

(b) flip the third bit from the left

1100 0110 0110

divide this by $G(x)$

```
             1000 1011
      _________________
11001 | 1100 0110 0110
        11001
        ---------
            11100
            11001
             10111
             11001
             -----
              11100
              11001
              -----
               0101
```

the result is not 0 so errors have been detected

(c) bit errors a multiple of $G(x)$ will not be detected i.e.

11001

Q7. $R = 4$ kbps $t_{prop} = 20$ msec

efficiency is $\dfrac{t_{trans}}{t_r + t_{trans}}$

$t_r = 2 \times t_{prop} = 40$ msec

$t_{trans} = L/R$

for 50 % efficiency

$t_{trans} = t_r = 40$ msec

$L = R \times t_{trans} = 4 \times 40 = 160$ bits

∴ for frame sizes of 160 bits or more the efficiency will be at least 50 %