Problem #1
A 7-bit word with binary value 1001001 is to be encoded using an even-parity Hamming code. What is the binary value after encoding?

a b 1 c 0 0 1 d 0 0 1

bit 3 = 1+2
5 = 1+4
6 = 2+4
7 = 1+2+4
9 = 1+8
10 = 2+8
11 = 1+2+8

1: 3,5,7,9,11 => even parity gives a = 1
2: 3,6,7,10,11 => even parity gives b = 1
4: 5,6,7 => even parity gives c = 1
8: 9,10,11 => even parity gives d = 1

Final binary value after encoding:
1 1 1 1 0 0 1 1 0 0 1

Problem #2
A bit stream 1101001 is transmitted using the standard CRC method described in the text. The generator polynomial is x^3+1. Show the actual bit string transmitted. Suppose that the second and sixth bits from the left are inverted during transmission. Determine whether the error is detected.

r = 3 (degree of generator polynomial)

M(x) => 1 1 0 1 0 0 1
G(x) = x^3+1 =>1 0 0 1
x^rM(x) => 1 1 0 1 0 0 1 0 0 0

```
                1 1 0 0 1 0 1
            ---------------------
1 0 0 1   | 1 1 0 1 0 0 1 0 0 0
            1 0 0 1
            ---------
              1 0 0 0
              1 0 0 1
              ---------
                  1 0 1 0
                  1 0 0 1
                  ---------
                      1 1 0 0
                      1 0 0 1
                      ---------
                        1 0 1   => remainder x^2+1
```

Bit string transmitted: 1 1 0 1 0 0 1 1 0 1

Bit string with errors: 1 0 0 1 0 1 1 1 0 1

```
          1 0 0 0 0 1 1
        ------------------
1 0 0 1 | 1 0 0 1 0 1 1 1 0 1
          1 0 0 1
          -------
              0 1 1 1 0
                1 0 0 1
                -------
                  1 1 1 1
                  1 0 0 1
                  -------
                    1 1 0
```

=> remainder indicates that error is detected

Problem 3.3

After stuffing, we get A B ESC ESC C ESC ESC ESC FLAG ESC FLAG D.

Problem 3.10

The encoded value is 101001001111.

Problem 3.11

If we number the bits from left to right starting at bit 1, in this example, bit 2 (a parity bit) is incorrect. The 12-bit value transmitted (after Hamming encoding) was 0xA4F. The original 8-bit data value was 0xAF.

Problem 3.17

Efficiency will be 50% when the time to transmit the frame equals the roundtrip propagation delay. At a transmission rate of 4 bits/ms, 160 bits takes 40 ms. For frame sizes above 160 bits, stop-and-wait is reasonably efficient.