

# CpE 319 Assignment 4

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## 1 Problem 2.36

An OC-12c has 12 times the bandwidth of an OC-1 all dedicated to one user, giving an available bandwidth of  $49.536 * 12 = 594.432$ .

## 2 Problem 2.37

	best	average	worst
Star	2	2	2
Ring	1	$n/2$	$n - 1$
Fully Interconnected	1	1	1

## 3 Problem 2.39

The transmission time for this data is:

$$T = \text{Time to transmit data} + \text{Store-and-forward} \quad (1)$$

$$T = \lceil \frac{x}{p} \rceil (h + p)b + (h + p)bk \quad (2)$$

To find the optimal value of  $p$ , we take the partial derivative with respect to  $p$ :

$$\frac{\partial}{\partial p} T = \frac{-xhb}{2p^2} + bk \quad (3)$$

Setting this equal to zero and solving for  $p$  gives the optimal value of  $p$ :

$$p = \sqrt{\frac{xh}{2k}} \quad (4)$$

## 4 Problem 2.46

$$S = [-1 + 1 - 3 + 1 - 1 - 3 + 1 + 1]$$

$$S \cdot A = [+1 - 1 + 3 + 1 - 1 + 3 + 1 + 1]/8 = +1 \quad (5)$$

$$S \cdot B = [+1 - 1 - 3 - 1 - 1 - 3 + 1 - 1]/8 = -1 \quad (6)$$

$$S \cdot C = [+1 + 1 + 3 + 1 - 1 + 3 - 1 - 1]/8 = +1 \quad (7)$$

$$S \cdot D = [+1 + 1 + 3 - 1 + 1 + 3 + 1 - 1]/8 = +1 \quad (8)$$

A sent 1, B sent 0, C sent 1, D sent 1.

## 5 Problem 3.1

If each packet has an 80% chance of success, the entire message has a  $0.8^{10} = 0.107$  probability of success. Thus, the message will need to be sent approximately 10 times on average to be successfully transmitted.

## 6 Problem 3.4

In a worst-case scenario, every byte of data would be a flag or escape sequence, causing the algorithm to send twice as many bytes (half of which are escapes for the data bytes).

## 7 Problem 3.7

Open-loop protocols don't require retransmission of data, so for networks with low data rates, they are desirable.

## 8 Problem 3.8

This still has a Hamming Distance of 2, since only two bit changes (one data and one parity) are needed to convert one codeword to another.

## 9 Problem 3.9

Five check bits are needed.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
0	1	1	0	1	0	1	1	0	0	1	1	0	0	1	1	1	0	1	0	1

## 10 Problem 3.10

The recieved value can be written as: 
$$\begin{array}{cccccccccccccc} \mathbf{1} & \mathbf{2} & 3 & \mathbf{4} & 5 & 6 & 7 & \mathbf{8} & 9 & 10 & 11 & 12 \\ \hline 1 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 1 \end{array}$$

Check bits with mismatched parity: 2

Error Syndrome: 2

Corrected value: 
$$\begin{array}{cccccccccccccc} \mathbf{1} & \mathbf{2} & 3 & \mathbf{4} & 5 & 6 & 7 & \mathbf{8} & 9 & 10 & 11 & 12 \\ \hline 1 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 1 \end{array}$$

Or, in hexadecimal, 0xA4F

The decoded data is: 
$$\begin{array}{cccccccc} \mathbf{1} & \mathbf{2} & 3 & \mathbf{4} & 5 & 6 & 7 & \mathbf{8} \\ \hline 1 & 0 & 1 & 0 & 1 & 1 & 1 & 1 \end{array}$$

Or, in hexadecimal, 0xAF.

## 11 Problem 3.17

$$x^r M(x) = 1 \ 0 \ 0 \ 1 \ 1 \ 1 \ 0 \ 1 \ 0 \ 0 \ 0 \ 0$$

$$\text{Remainder of } \frac{x^r M(x)}{x^3+1} = 0 \ 0 \ 0 \ 1$$

$$\text{Transmitted bit string: } 1 \ 0 \ 0 \ 1 \ 1 \ 1 \ 0 \ 1 \ 0 \ 0 \ 0 \ 1$$

$$\text{Error bit string: } 1 \ 0 \ 0 \ 1 \ 1 \ 1 \ 0 \ 1 \ 0 \ 1 \ 0 \ 1$$

$$\text{Remainder of } \frac{T(x)+E(x)}{G(x)} = 0 \ 1 \ 0 \ 0$$

Since the remainder is nonzero, we have indeed detected the transmission error.

This generator polynomial will not detect some errors, such as two-bit errors where the flipped bits are four apart, e.g.  $E(x) = x^i(x^3 + 1)$ .