Ch:10 Error Detection & Correction

[1] How does a single-bit error Differ from a Burst Error?

* Single Bit-Error	Burst Error
Only one Bit of The Data is Corrupted (Changed).	More Than one Bit is Corrupted (Changed).
Ex: 0010 → 1010	Ex: 00110 → 10010

[2] Discuss The Concept of Redundancy in Error Detection & Correction?

* The Concept of Redundancy in Error Detection & Correction

We need to add extra Bits to The Data, These Redundant Bits are added by the sender & Removed by the Receiver.
These Bits allows the Reciever to Detect or Correct Corrupted Bits in the Data.

[3] Distinguish Between Forward Error Correction Versus Error Correction by Retransmission.

* Forward Error Correction

↳ This the process in which The Reciever Tries to Correct The Corrupted Bits by using the Redundant Bits.

* Retransmission

↳ This The process in which The Reciever detect the occurrance of errors & ask The sender To Resend (Retransmit) The Data.

[4] What is the Definition of a linear block code? What is The Definition of a Cyclic Code?

* linear Block code

↳ It's a code in which The Exclusive or (Xor) of Two Codewords Create another Valid Codeword.

* Cyclic Code.

↳ It's a special linear Block Code with one Extra property, if a Codeword is Cyclically Shifted (Rotated) The Result is another Codeword.

5) What is The Hamming Distance?
What is The minimum Hamming Distance?

* The Hamming Distance:
  - The number of Difference Between The Bits of Two words with The Same Size.
  - Hamming Distance Can found by Applying Xor operation Between the Two Words & Count The number of 1s in The Result.

* The Minimum Hamming Distance.
  - is The Smallest Hamming Distance (The Smallest number of 1s) Between set of Words.

6) How is The Simple parity Check Releated to The Two-Dimenssional parity Check?

The simple parity Check uses one Redundant bit For The Whole Data Unit.

In Two-dimenssional parity check, orginal Data is organized in a Table Consist of Rows & Colums. The parity bit is then Calculated For each Row & Column.

7 In CRC, show The Releationship Between The Following Entities (size means The number of Bits)

(a) The size of The Dataword & The size of The Codeword.

* The Releationship is based on.

$n = k + r$

$n \longrightarrow$ The Size of The Code word

$k \longrightarrow$ The Size of The Dataword

$r \longrightarrow$ The Redundent Bits.

(b) The size of The Divisor & The Reminder

The Reminder is always one bits smaller Than Divisor (more Then one Bit).

(c) The degree of The polynominal Generator & The Size of The Divisor.

The Degree of The Generator is one less than The Divisor.

(d) The Degree of The polynominal Generator & The Size of the Reminder.

The Degree of The Generator is The Same Size as The Size of The Reminder.

11) What is The Maximum effect of a 2ms burst of Noise on Data Transmited at The Following Rates?

a) 1500 bps.

Effected Bits = Data Rate * Burst Duration

$= 1500 \times 2 \times 10^{-3} = \underline{3 \text{ Bits}}$

b) 12 Kbps.

Effected Bits $= 12 \times 10^{3} \times 2 \times 10^{-3} = \underline{24 \text{ Bits}}$

(c) 100 Kbps.

$$\text{Effected Bits} = 100 \times 10^{3} \times 2 \times 10^{-3} = \underline{200 \text{ Bits}}$$

(d) 100 Mbps

$$\text{Effected Bits} = 100 \times 10^{6} \times 2 \times 10^{-3} = \underline{200 \times 10^{3} \text{ Bits}}$$

$$\underline{200 \text{ KBits}}$$

11 Apply the Exclusive-or Operation on the following pair of patterns ($\oplus \rightarrow$ xor).

Xor

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0

(a) $(10001) \oplus (10000)$

$$\begin{array}{r} 10001 \\ \oplus\ 10000 \\ \hline 0000\boxed{1} \end{array} \qquad d_{min} = 1$$

(b) (10001) ⊕ (10001) → (What do you infer From The Result)?

$$\begin{array}{r} 10001 \\ \oplus\ 10001 \\ \hline 00000 \end{array}$$

d_{min} (minimum Hamming Distance)

$d_{min} = 0$

(c) (11100) ⊕ (00000) → (What do you infer From The Result?)

$$\begin{array}{r} 11100 \\ \oplus\ 00000 \\ \hline \boxed{111}00 \end{array}$$

$d_{min} = 3$

(d) (10011) ⊕ (11111) → (what do you infer from the Result?)

$$\begin{array}{r} 10011 \\ \oplus\ 11111 \\ \hline 0\boxed{11}00 \end{array}$$

$d_{min} = 2$

[13] In Table 10.1 The sender sends Dataword [10], A 3-bit burst error Corrupts the Codeword. Can The Reciever Detect the Error? Defend your Answer.

Table	Dataword	Codeword
	10	101

3- Bit burst Error

Codeword = 101

Will be changed to 010

010 → Not one of The Valid Codeword
So the Reciever Detect The Error &
Ask the sender for Retransmission.

[14] In table 10.2 The sender send Dataword [10]. If a 3-bit burst Error Corrupts the First Three Bits of The Codeword, Can The Reciever Detect The Error? Defend you Answer.

Table

Dataword	Codeword
10	10101

The Codeword of 10 is 10101 is Changed to 01001

10101 Changed to 01001

01001 Not one of The Valid Codeword So the Reciever Detect the Error & Ask The sender for ReTransmision.

15) What is The Hamming Distance for The Following Codewords

a) d(10000, 00000)

Xor
10000
00000
10000

Hamming Distance = number of 1 = $\boxed{1}$

(b) d(10101, 10000) = $\boxed{2}$

$$\begin{array}{r} 10101 \\ \text{xor}\ 10000 \\ \hline 00101 \end{array}$$

(c) d(1111, 1111) = $\boxed{0}$

$$\begin{array}{r} 1111 \\ \text{xor}\ 1111 \\ \hline 0000 \end{array}$$

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0

(d) d(000, 000) = $\boxed{0}$

$$\begin{array}{r} 000 \\ \text{xor}\ 000 \\ \hline 000 \end{array}$$

(6) Find The Minimum Hamming Distance For the Following Cases.

a) Detection of Two Errors.

number of Errors

For Detection = $d_{min} = s+1$

$d_{min} = 2+1 = \boxed{3}$

(b) Correction of Two Errors

For Correction. $d_{min} = 2t+1$ (Two Errors)

$d_{min} = (2*2)+1 = \boxed{5}$

(C) Detection of 3 Errors or Correction of 2 Errors.

For Detection : $d_{min} = S+1 = 3+1 = \boxed{4}$

For Correction : $d_{min} = 2t+1 = 2*2+1 = \boxed{5}$

The $d_{min} = \boxed{5}$

(d) Detection of 6 Errors or Correction of 2 Errors.

For Detection:

$$d_{min} = s+1$$
$$= 6+1 = \boxed{7}$$

For Correction:

$$d_{min} = 2t+1$$
$$= 2 \times 2+1 = \boxed{5}$$

The $d_{min} = \boxed{7}$

(b) Dataword: 0111 Burst Error: E∇∇∇∇∇E

Dataword: 0111 → Codeword: 0111001

Codeword (with Error) → 1111000

↳ Not Found in The Valid Codewords in Table.

1111000 → This Codeword is Detected Correctly.

(c) Dataword: 1111 Burst Error: E∇E∇∇∇E

Dataword: 1111 → Codeword 1111111

↳ Codeword (With Error) → 0101110

↳ This Codeword Found in The Valid Codewords in the Table.

(d) Dataword: 0000 Burst Error: EE∇E∇∇∇

Dataword: 0000 → Codeword: 0000000

Codeword (with Error) → 1101000

↳ This Codeword Found in the Valid Codewords in the Table.

This Codeword Can Corrected (since 1-Bit Error).

0011001 → Dataword : 0111

(c) Dataword : 1111 Burst Error : E∇∇∇∇∇E

Codeword : 1111111

Codeword (with Error) : 0111110

This Codeword Can't be Corrected (Since Two-Bit Error).

(d) Dataword : 0000 Burst Error : EE∇∇∇∇E

Codeword : 0000000

Codeword (with Error) : 1100001

Isn't a Valid Codeword (not found in table)

This Codeword Can't be Corrected.

(since Three Bit-Error).

$\boxed{K = 11} \longrightarrow 2^m - 1 - m = 2^4 - 1 - 4 = 11$

$\boxed{2}$ Apply The Following operations on The Corresponding polymominals.

a) $(x^3 + x^2 + x + 1) \oplus (x^4 + x^2 + x + 1)$

=

$= x^4 + 1x^3$

23

(b) $(x^3+x^2+x+1) - (x^4+x^2+x+1)$

$= x^4 + x^3$

(a) $(x^3+x^2+x+1) / (x^2+1)$

$= x+1$

$$\begin{array}{r|l} & x+1 \\ \hline x^2+1 & x^3+x^2+x+1 \\ & \cancel{x^3} + \cancel{x} \\ \hline & x^2+1 \\ & x^2+1 \\ \hline & - - - \end{array}$$

(d) $(x^3+x^2) * (x^4+x^2+x+1)$

$= x^7 + x^5 + \cancel{x^4} + \cancel{x^3} + x^6 + \cancel{x^4} + \cancel{x^3} + x^2$

$= x^7 + x^6 + x^5 + x^2$

(25) Answer The following Questions:

ⓐ What is The polynomial Representation of 101110

$$\begin{array}{cccccc} 1 & 0 & 1 & 1 & 1 & 0 \\ x^5 & x^4 & x^3 & x^2 & x^1 & x^0 \end{array}$$

$= x^5 + x^3 + x^2 + x^1$

ⓑ What is The Result of Shifting 101110 Three Bits To the left?

← shift left. 101110 $\boxed{\ldots}$

$101110\,\boxed{000} = \boxed{101110000}$

ⓒ Repeat part ⓑ using polynomials?

$$\begin{array}{ccccccccc} 1 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ x^8 & x^7 & x^6 & x^5 & x^4 & x^3 & x^2 & x^1 & x^0 \end{array}$$

$= x^8 + x^6 + x^5 + x^4$

(d) What is The Result of shifting 101110 four bits to Right.

shift Right $\longrightarrow$

101110

$\downarrow$

000010

(e) Repeat part (d) using polynomials.

$000010 = x$

$- - - x^1 x^0$

30) Given The Dataword 1010011110
& The Divisor 10111

a) Show The Generation of The Codeword at The sender (Using Binary Division).

Dataword = 1010011110
Reminder = 1010

Codeword:

$\boxed{10100111101010}$

Dataword ↙ ↘ CRC checksum

Sender: $\frac{\text{Dataword}}{\text{Divisor}}$

33

1010011110 → Dataword

10111 | 1010011110 $\boxed{0000}$

10111
00111
00000
01111
00000
11111
10111
10001
10111
01100
00000
11000
10111
11110
10111
10010
10111
01010
00000
$\boxed{1010}$

Reminder

Codeword

$\boxed{1010011110\boxed{1010}}$

Reciever = $\frac{\text{Codeword}}{\text{Divisior}}$ $\boxed{34}$

(b) Show The checking of The Codeword at The Reciever (Assume No Error).

1010011110 ⟶ Dataword

```
10111 | 10100111101010 ⟶ Code word
        10111
        00011 1
         00000
          01111
          00000
           01111
           10111
            10001
            10111
             01100
             00000
              11001
              10111
               11100
               10111
                10111
                10111
               |00000|
```

Reminder ⟵ 00000

Final: 2018 - 2019

Beni-Sueif University
Faculty of Computer and
Information systems
Time: 2 Hrs.

Subject: Data Communications

Year: 2nd. Year

ch(1)

Question 1: [12 marks]

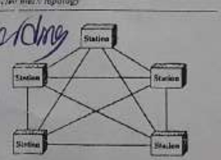
1. The effectiveness of a data communications system depends on four fundamental characteristics?
2. A data communications system has five components shown in figure1. define, redraw and complete with component labels:

Figure 1 *Five components of data communication*

3. Audio ...... is refers to the recording or broadcasting of sound or music, by nature different from text, numbers, or images.
4. Figure 2: find the number of physical links in a fully connected network?

Figure 2 *A fully connected mesh topology*

Video: is Refers to The Recording or broadcasting of picture or Movie.



$\frac{n(n-1)}{2}$

....

ch(2)

Question 2: [5 marks]

A. Which of the following statements are true? And false?
   a) Transport: To establish, manage, and terminate sessions Transport (...X..)
   b) Physical: To allow access to network resources (..✓X.....)
   c) Data link: To move packets from source to destination; to provide internetworking (.X)
   d) Session: To organize bits into frames; to provide hop-to-hop delivery (..X..)
   e) Application: To translate, encrypt, and compress data(...X..)
   f) TCP/IP: is a hierarchical protocol made up of noninteractive modules (...X..)

B. The power we use at home has a frequency of 50 Hz in Europe. Find in MS the period of this sine?

-PTO-

F = 50 Hz.

$T = \frac{1}{F} = \boxed{}$ MS Micro Second.

ch(3)

Question 3: **[8 marks]**

a. If a periodic signal is decomposed into five sine waves with frequencies of 100, 300, 500, 700, and 900 Hz, what is its bandwidth? Draw the spectrum, assuming all components have a maximum amplitude of 20 V.

b. A nonperiodic composite signal has a bandwidth of 300 kHz, with a middle frequency of 180 kHz and peak amplitude of 50 V. The two extreme frequencies have an amplitude of 10. Draw the frequency domain of the signal

B = 5KHZ

c. A digitized voice channel is made by digitizing a 5-kHz bandwidth analog voice signal. We need to sample the signal at twice the highest frequency (two samples per hertz). We assume that each sample requires 8 bits. What is the required bit rate? Bit Rate = $5 \times 10^3 \times 2 \times 8 = \boxed{\quad}$ bps

d. A line has a signal-to-noise ratio of 1000 and a bandwidth of 4000 KHz. What is the maximum data rate supported by this line?

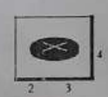
ch(8)

Question 4: **[10 marks]**

a. Figure 3 shows a switch (router) in a datagram network. Find the output port for packets with the following destination addresses: Packet 1: 7176, Packet 2: 1233, Packet 3: 8766, and Packet 4: 9144

Figure 3

Destination address	Output port
1233	3
1456	2
3255	1
4470	4
7176	2
8766	3
9144	2



Yes.

b. Can a routing table in a datagram network have two entries with the same destina-tion address? Explain.

Question 5: **[15 marks]**

ch(10)

1. Find the minimum Hamming distance for the following cases:
   a. Detection of two $d_{min} = 2+1 = 3$
   b. Correction of two errors. $d_{min} = 2t+1 = (2 \times 2)+1 = \boxed{5}$
   c. Detection of 3 errors or correction of 2 errors. Detection = 3+1 = 4 Correction = 2×2+1 = 5 $\boxed{d_{min} = 5}$
   d. Detection of 6 errors or correction of 2 errors.
   Detection = 6+1 = 7 Correction = 2×2+1 = 5 $\boxed{d_{min} = 7}$
2. Apply the following operations on the corresponding polynomials:
   a. (x3 + x1 + X + 1) + (x4 + x1 + x + 1) = $x^4 + x^3$
   b. (x3 + x1 + x + 1) - (x4 + x2 + x + 1) = $x^4 + x^3$
   c. (x3 + x1) X (x4 + x2 + x + 1) = $x^7 + x^6 + x^5 + x^2$
   d. (x3 + x2 + x + 1) / (x2 + 1) = $x+1$

ch(3)

3. In a digital transmission, the sender clock is 0.2 percent faster than the receiver clock. How many extra bits per second does the sender send if the data rate is 1 Mbps? Bits = $\frac{0.2}{100} \times 10^6 = \boxed{\quad}$ bits.

....

Best Wishes....

Dr. Hany Elnashar