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| **KING SAUD UNIVERSITY**  **COLLEGE OF COMPUTER AND INFORMATION SCIENCES**  **COMPUTER SCIENCE DEPARTMENT** | | | |
| **CSC 329: Computer Network** | **Tutorial 4** | | **1st Semester 1437-1438** |
| **Name:** | | **Student ID:** | |
| **Serial Number:** | | **Section Number:** | |

**Part1: Multiple-Choice Questions**

**1) Which error detection method consists of just one redundant bit per data unit?**

a. Simple parity check

b. Two-dimensional parity check

c. CRC

d. Checksum

**2) Which error detection method consists of a parity bit for each data unit as well as an entire data unit of parity bits?**

a. Simple parity check

b. Two-dimensional parity check

c. CRC

d. Checksum

**3) The Hamming code is a method of \_\_\_\_\_\_\_**

a. Error detection

b. Error correction

c. Error encapsulation

d. (a)and(b)

**4) Which error detection method involves the use of parity bits?**

a. Simple parity check

b. Two-dimensional parity check

c.CRC

d. (a) and (b)

**5) If the ASCII character c is sent and the character g is received, what type of error is this? The ASCII code for c= 110 0011, g= 1100111**

a. Single-bit

b. Multiple-bit

c. Burst error

d. Recoverable

**6) Which error detection method can detect a burst error?**

a. simple parity check

b. Two-dimensional parity check

c. (b) and (c)

d. None of the above

**7) In \_\_\_\_\_ coding, we divide our message into blocks, each of k bits, called \_\_\_.**

1. block; blockwords
2. linear; datawords
3. block; datawords
4. none of the above

**8) A receiver receives the code 11001100111. When it uses the Hamming encoding algorithm, the result is 0101. Which bit is in error?**

a. 1

b. 3

c. 5

d. none of the above

**Part2: Exercises**

1) assuming odd parity, find the parity bits for the following data units.

**0101110** 🡺 01011101

**1000100** 🡺 10001001

**1100111** 🡺 11001110

2) A receiver receives the bit pattern **01001001** if the system is using even parity, is the pattern in error?

Yes , because the number of 1s is odd

3) Find the parity bits for the following bit pattern, using two-dimensional parity. Assume even parity.

**1010101 1110101 0110101 1010100**

1010101 0

1110101 1

0110101 0

1010100 1

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1000001 0

4) The following block is received by a system using two-dimensional even parity.

Is there any error in the block?

**10110101 01001101 11010010 11001111**

10110101 1

01001101 0

11010010 0

11001111 0

11100101

Yes, there is an error.

8) For each data unit of the following sizes, find the minimum number of redundancy bits needed to correct one single-bit error

1. **8**

m=8

2r >= 8 + r + 1

2r >= 9 + r

16 >= 13

r=4

1. **30**

m=30

2r >= 30 + r + 1

2r >= 31 + r

64 >= 37

r=6

11. Hamming code is a technique that is used to achieve forward error control. This allows a receiver to correct any single error, if any, in the received message. If the transmitted character is **01001010**, generate the Hamming codeword.

1. Calculate the number of redundant bits:

2r >= m + r + 1 we have 8 bit of data so,

2r >= 8 + r + 1

r=4

16 > 13

We have 4 redundant bits which gives us a total of 4+8=12 bit

1. Implementing the Hamming codeword:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 0 | 1 | 0 | 0 | **r8** | 1 | 0 | 1 | **r4** | 0 | **r2** | **r1** |

***r1:*** 1, 3, 5, 7, 9, 11

***r2:*** 2, 3, 6, 7, 10, 11

***r4:*** 4, 5, 6, 7,12

***r8:*** 8, 9, 10, 11,12

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | **r8** | 1 | 0 | 1 | **r4** | 0 | **r2** | **r1** |
| 0 | 1 | 0 | 0 | **r8** | 1 | 0 | 1 | **r4** | 0 | **r2** | **1** |
| 0 | 1 | 0 | 0 | **r8** | 1 | 0 | 1 | **r4** | 0 | **0** | **1** |
| 0 | 1 | 0 | 0 | **r8** | 1 | 0 | 1 | **0** | 0 | **0** | **1** |
| 0 | 1 | 0 | 0 | **1** | 1 | 0 | 1 | **0** | 0 | **0** | **1** |

31. Assume that the **received** Hamming codeword is:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |

Deduce the original data word from the above codeword after correction if any error.

To check the received data we will calculate the party bit for each combination

**r1 :** 1,3,5,7,9,11 (3) 🡪 1

**r2 :** 2,3,6,7,10,11 (3) 🡪1

**r4:** 4,5,6,7 (2)🡪0

**r8:** 8,9,10,11 (2) 🡪0

r8 r4 r2 r1

0 0 1 1 🡪 error in bit in position 3 should be 1

The Correct code word is

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | **1** | 1 | 0 |

Data word is 1010111

8) implement the Haming codeword for 1011.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| d7 | d6 | d5 | p4 | d3 | p2 | p1 |
| 1 | 0 | 1 |  | 1 |  |  |

Determine p1, p2 and p3.

P1 = p1 d3 p5 d7

= 1 => 1 1 1

P2 = p2 d3 d6 d7

= 0 = >1 0 1

P4 = p4 d5 d6 d7

1. =>1 0 1 p4 is 0 cause number of 1’s are even.. ( even parity bit )

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| d7 | d6 | d5 | p4 | d3 | p2 | p1 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 |

So receiver will send 1010101 in channel to the transmitter.

**9)**

**If the 7 bit haming code word received is 1011011 assuming the even parity state whether the received code word is correct or wrong. If worng locate the bit having error.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| d7 | d6 | d5 | p4 | d3 | p2 | p1 |
| 1 | 0 | 1 | 1 | 0 | 1 | 1 |

Solution :

P4 = p4 d5 d6 d7

= 1 => 1 0 1 p4 is 1

P2 = p2 d3 d6 d7

= 0 = >0 0 1 p2 = 0

P1 = p1 d3 p5 d7

= 1=> 011

P1 = 1.

P4 p2 p1 = 101 = 5..

Error at 5th bit.

Corrected answer after changing the 5th bit will be : 1001011