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B TECH 3RD YEAR

16/10/20

CN Tutorial 7

Ans :-

Given dataword = 101001110
Divisor = 10111

a) Binary division:-

```
        1
10111 ) 101001110
       -10111
        110001
        10111
```

```
        101001110
10111 ) 1 0 1 0 0 1 1 1 1 0
        1 0 1 1 1
        ---------
        0 0 0 1 1 1
        0 0 0 0 0 0
        -----------
            1 1 1 1
        0 0 0 0 0 0 0
        -------------
            1 1 1 1 1
            1 0 1 1 1
        -------------
              1 0 0 0 1
              1 0 1 1 0
        ---------------
              0 1 1 0 0
              0 0 0 0 0
        ---------------
                1 1 0 0 0
                1 0 1 1 1
        -----------------
                1 1 1 1 0
              - 1 0 1 1 0
        -----------------
                  1 0 0 1 0
                  1 0 1 1 0
        -------------------
                    1 0 1 0 0
                    0 0 0 0 0
```

CRC Checksum was 1010
Codeword was 10100111101010

b) Binary division at receiver's side :-

```
            1010011110
10111 | 10100 11110 1010
        10111
        00111
        00000
         001111
         00000
          11111
          10111
           10001
           10111
            01100
            00000
             11001
             10111
              10111
              10111
              00000.
```

Hence, remainder is 0. It is verified.

2) Value of $d_{min} = 3$

We know that

$$n = k + m$$

and, $2^m = k + m + 1$

Here, $k \geq 11$ so $2^m - m - 1 \geq 11$

So $m = 4$.

Hence, $n = k + m = \underline{\underline{15}}$

Thus, $n = 15$, $k = 11$

3) Given ~~d = 10101~~ 10101, 11110, 01110

After a 2D parity check,

~~d = 0~~ X - - 1

10101	1
11110	0
01110	1
00101	0

Hence,
the final message sent will be
101011 111100 011101 001010

Ans 4: Given, 10101, 11110, ~~0110~~ 01110

d(10101, 11110) = 3
d(10101, 01110) = 4
d(11110, 01110) = 1

Ans 5: Given,
10011001111000100010010010000100

It is divided into 4 segments of 8 bits each

At the sender side,
the segments are:
10011001, 11100010, 00100100, 10000100.

Add all the segments,
We get,
1000100011
Since the result contains 10 bits, 2 bits are wrapped around,
00100011 + 10 = 00100101 (8 bits)
Taking 1's complement, 11011010.
Thus, checksum value is 11011010.

b) Let us assume that the data items are divided into words of 8 bits.

- ~~Let~~ It is clearly observed that if the swapped bits are same, then there is no issue.
- However, let ith bit ~~of~~ be swapped with jth bit.
- Then, the difference in the checksum, is given by,

$$diff = \left|2^{7-i\%8} - 2^{7-j\%8}\right|, \text{ assuming } bit[i] \wedge bit[j] = 1$$

- ~~Now, when we take 1's complement of the number,~~

~~new diff = 2~~

Hence, due to this difference, the error can be detected easily.

7) Forward error correction is an error ~~detectio~~ correction technique to detect and correct ~~one~~ a limited number of errors in transmitted data without the need of transmission.

In this method, the sender sends a redundant error correcting code along with the data frame. The receiver performs necessary checks based on the redundant bits.

If it finds that the data is free from errors, it executes error correcting code that generates the actual ~~#~~ frame. It then removes the redundant bits before passing the message to upper layers.