

Assignment-3

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Task:1

Problem-01:

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A bit stream 1101011011 is transmitted using the standard CRC method. The generator polynomial is x^4+x+1 . What is the actual bit string transmitted?



The screenshot shows a C++ code editor with a file named 'Untitled'. The code implements a CRC calculation using XOR and modulo-2 division. The output window shows the results of the calculation for the input data '1101011011' and key '10011'.

```
1 #include <iostream>
2 #include <string>
3 #include <cmath>
4 #include <algorithm>
5 using namespace std;
6
7
8 // XOR between two binary strings
9 string findXor(string a, string b) {
10     string result = "";
11     for (int i = 1; i < b.length(); i++)
12         result += (a[i] == b[i]) ? '0' : '1';
13     return result;
14 }
15
16 // Modulo-2 division
17 string mod2div(string dividend, string divisor) {
18     int pick = divisor.length();
19     string tmp = dividend.substr(0, pick);
20
21     while (pick < dividend.length()) {
22         if (tmp[0] == '1')
23             tmp = findXor(divisor, tmp) + dividend[pick];
24         else
25             tmp = findXor(string(pick, '0'), tmp) + dividend[pick];
```

Output: Finished

```
Finished in 0 ms
=== TASK 1 ===
Data: 1101011011
Key: 10011
Remainder: 1110
Transmitted Codeword: 11010110111110
```

```
Run Code: Untitled
Save C++
Output: Finished Clear Console

35 }
36
37 // Encode data with CRC
38 string encodeData(string data, string key) {
39     int keyLen = key.length();
40     string appendedData = data + string(keyLen - 1, '0');
41     string remainder = mod2div(appendedData, key);
42     cout << "Remainder: " << remainder << endl;
43     return data + remainder;
44 }
45
46 int main() {
47     string data = "1101011011";
48     string key = "10011"; //  $x^4 + x + 1$ 
49
50     cout << "=== TASK 1 ===" << endl;
51     cout << "Data: " << data << endl;
52     cout << "Key: " << key << endl;
53
54     string codeword = encodeData(data, key);
55     cout << "Transmitted Codeword: " << codeword << endl;
56
57     return 0;
58 }
59
```

```
Finished in 0 ms
=== TASK 1 ===
Data: 1101011011
Key: 10011
Remainder: 1110
Transmitted Codeword: 1101011011110
```

Task:2

Problem-02:

A bit stream 10011101 is transmitted using the standard CRC method. The generator polynomial is x^3+1 .

1. What is the actual bit string transmitted?
2. Suppose the third bit from the left is inverted during transmission. How will receiver detect this error?

Run Code

Untitled

Save

C++

Output: Finished

Clear Console

```
1 #include <iostream>
2 #include <string>
3 #include <cmath>
4 #include <algorithm>
5 using namespace std;
6 // XOR between two binary strings
7 string findXor(string a, string b) {
8     string result = "";
9     for (int i = 1; i < b.length(); i++)
10         result += (a[i] == b[i]) ? '0' : '1';
11     return result;
12 }
13 // Modulo-2 division
14 string mod2div(string dividend, string divisor) {
15     int pick = divisor.length();
16     string tmp = dividend.substr(0, pick);
17
18     while (pick < dividend.length()) {
19         if (tmp[0] == '1')
20             tmp = findXor(divisor, tmp) + dividend[pick];
21         else
22             tmp = findXor(string(pick, '0'), tmp) + dividend[pick];
23         pick++;
24     }
25     if (tmp[0] == '1')
```

Run Code

Untitled

Save

C++

Output: Finished

Clear Console

```
24     }
25     if (tmp[0] == '1')
26         tmp = findXor(divisor, tmp);
27     else
28         tmp = findXor(string(pick, '0'), tmp);
29     return tmp;
30 }
31 // Encode data with CRC
32 string encodeData(string data, string key) {
33     int keyLen = key.length();
34     string appendedData = data + string(keyLen - 1, '0');
35     string remainder = mod2div(appendedData, key);
36     cout << "Remainder: " << remainder << endl;
37     return data + remainder;
38 }
39 // Receiver check
40 bool receiverCheck(string codeword, string key) {
41     string remainder = mod2div(codeword, key);
42     return (remainder.find('1') == string::npos);
43 }
44 int main() {
45     string data = "10011101";
46     string key = "1001"; // x^3 + 1
47     cout << "=== TASK 2 ===" << endl;
48     cout << "Data: " << data << endl;
```

Run Code

Untitled

Save

C++

Output: Finished

Clear Console

```
39 // Receiver check
40 bool receiverCheck(string codeword, string key) {
41     string remainder = mod2div(codeword, key);
42     return (remainder.find('1') == string::npos);
43 }
44 int main() {
45     string data = "10011101";
46     string key = "1001"; // x^3 + 1
47     cout << "=== TASK 2 ===" << endl;
48     cout << "Data: " << data << endl;
49     cout << "Key: " << key << endl;
50     string codeword = encodeData(data, key);
51     cout << "Transmitted Codeword: " << codeword << endl;
52     // Introduce error at 3rd bit
53     string received = codeword;
54     received[2] = (received[2] == '0') ? '1' : '0';
55     cout << "Received (error at bit 3): " << received << endl;
56
57     if (receiverCheck(received, key))
58         cout << "Receiver: No Error Detected" << endl;
59     else
60         cout << "Receiver: Error Detected" << endl;
61     return 0;
62 }
63 }
```