OSCN LAB – 3

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Task:1

Problem-01: 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?

Ans: Given:

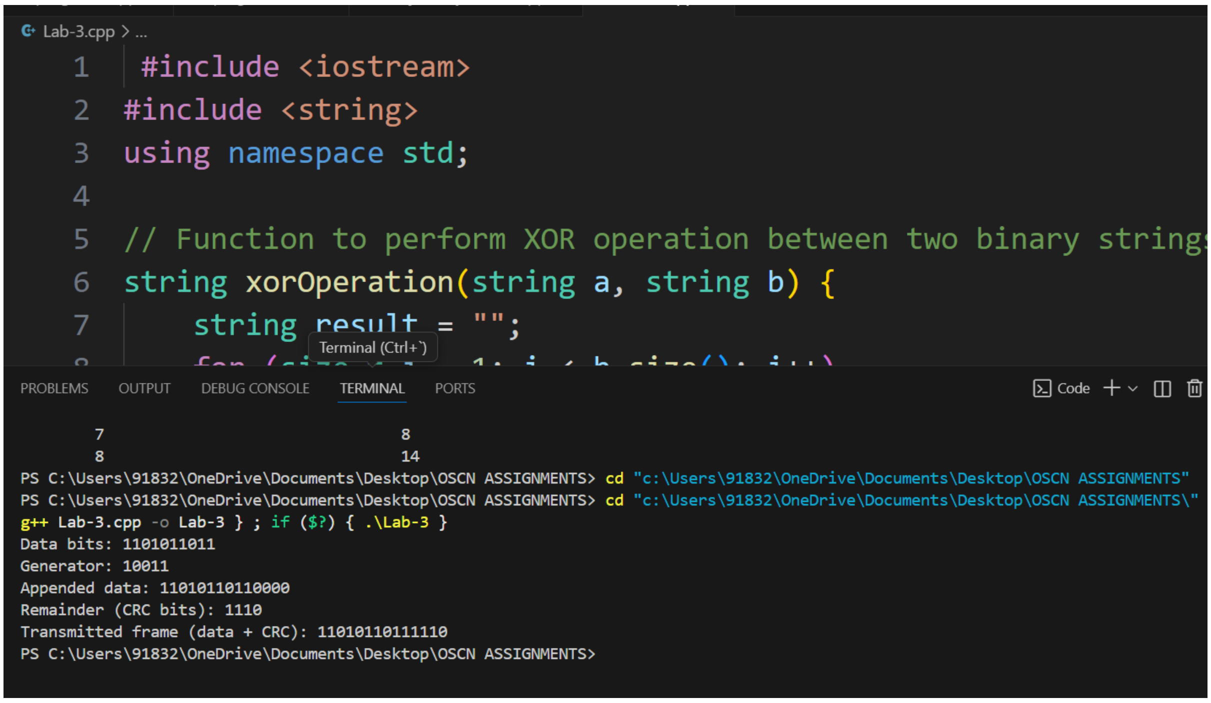
- Data bits: 1101011011
- Generator polynomial: $x^4 + x + 1$ → generator bits: 10011

Code:

```
#include <iostream>
#include <string>
using namespace std;

// Function to perform XOR operation between two binary strings
string xorOperation(string a, string b) {
  string result = "";
  for (size_t i = 1; i < b.size(); i++)
    result += (a[i] == b[i]) ? '0' : '1';
  return result;
}

// Function to perform modulo-2 division
string mod2Division(string dividend, string divisor) {
  int pick = divisor.size();
  string tmp = dividend.substr(0, pick);
  int n = dividend.size();
```

```
    while (pick < n) {
        if (tmp[0] == '1')
            tmp = xorOperation(divisor, tmp) + dividend[pick];
        else
            tmp = xorOperation(string(pick, '0'), tmp) + dividend[pick];
        pick++;
    }

    // For the last n bits
    if (tmp[0] == '1')
        tmp = xorOperation(divisor, tmp);
    else
        tmp = xorOperation(string(pick, '0'), tmp);

    return tmp;
}

int main() {
    string data = "1101011011";
    string generator = "10011";

    int m = generator.size();
    string appendedData = data + string(m - 1, '0'); // Append (m-1) zeros

    cout << "Data bits: " << data << endl;
    cout << "Generator: " << generator << endl;
    cout << "Appended data: " << appendedData << endl;

    string remainder = mod2Division(appendedData, generator);
    cout << "Remainder (CRC bits): " << remainder << endl;
    // XOR remainder with appended data to get transmitted codeword
    string transmitted = data + remainder;
    cout << "Transmitted frame (data + CRC): " << transmitted << endl;

    return 0;
}
```

Output:



```cpp
#include <iostream>
#include <string>
using namespace std;

// Function to perform XOR operation between two binary string
string xorOperation(string a, string b) {
    string result = "";
```

```
       7                            8
       8                            14
PS C:\Users\91832\OneDrive\Documents\Desktop\OSCN ASSIGNMENTS> cd "c:\Users\91832\OneDrive\Documents\Desktop\OSCN ASSIGNMENTS"
PS C:\Users\91832\OneDrive\Documents\Desktop\OSCN ASSIGNMENTS> cd "c:\Users\91832\OneDrive\Documents\Desktop\OSCN ASSIGNMENTS\"
g++ Lab-3.cpp -o Lab-3 } ; if ($?) { .\Lab-3 }
Data bits: 1101011011
Generator: 10011
Appended data: 11010110110000
Remainder (CRC bits): 1110
Transmitted frame (data + CRC): 11010110111110
PS C:\Users\91832\OneDrive\Documents\Desktop\OSCN ASSIGNMENTS>
```

Explanation

1. **Data bits** = 1101011011
2. **Generator polynomial** = $x^4 + x + 1$ → **Generator bits** = 10011
3. Append 4 zeros (degree of generator = 4) to data → 11010110110000
4. Perform **mod-2 division** (XOR based) → remainder = **1110**
5. **Actual transmitted frame** = 1101011011 + 1110 = **11010110111110**

Therefore, the **actual bit string transmitted** is: `11010110111110`

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?

Code:

```
#include <iostream>

#include <string>

using namespace std;


// XOR operation between two binary strings (skip the first bit)

string xorOp(string a, string b) {

    string result = "";

    for (int i = 1; i < b.size(); i++) {

        if (a[i] == b[i])

            result += '0';

        else

            result += '1';

    }

    return result;

}


// Perform Modulo-2 Division

string mod2Division(string dividend, string divisor) {

    int pick = divisor.size();

    string tmp = dividend.substr(0, pick);

    int n = dividend.size();
    while (pick < n) {
        if (tmp[0] == '1')
            tmp = xorOp(divisor, tmp) + dividend[pick];
        else
            tmp = xorOp(string(pick, '0'), tmp) + dividend[pick];
        pick++;
    }

    if (tmp[0] == '1')
        tmp = xorOp(divisor, tmp);
    else
        tmp = xorOp(string(pick, '0'), tmp);

    return tmp;
}

// Flip (invert) a bit at a given position
string flipBit(string s, int pos) {
    if (pos < 0 || pos >= s.size())
        return s;
    if (s[pos] == '0')
        s[pos] = '1';
    else
        s[pos] = '0';
    return s;
}

int main() {
    string data = "10011101";   // Given data bits
    string generator = "1001";  // Given generator polynomial (x^3 + 1)
    int genDegree = generator.size() - 1;
```

```
cout << "Data bits:       " << data << endl;

cout << "Generator bits:  " << generator << endl;


// Step 1: Append (m-1) zeros

string appended = data + string(genDegree, '0');

cout << "Appended data:   " << appended << endl;


// Step 2: Perform division to find remainder (CRC)

string remainder = mod2Division(appended, generator);

cout << "Calculated CRC (remainder): " << remainder << endl;


// Step 3: Form transmitted frame

string transmitted = data + remainder;

cout << "Transmitted frame (data + CRC): " << transmitted << endl;


// Step 4: Simulate bit error (flip 3rd bit from left)

int flipIndex = 2; // 0-based index

string received = flipBit(transmitted, flipIndex);

cout << "\nSimulate error: flip 3rd bit from left" << endl;

cout << "Received frame: " << received << endl;


// Step 5: Receiver checks CRC again

string recvRemainder = mod2Division(received, generator);

cout << "Receiver remainder: " << recvRemainder << endl;


// Step 6: Check if remainder is all zeros

bool isZero = true;

for (int i = 0; i < recvRemainder.size(); i++) {

    if (recvRemainder[i] != '0') {

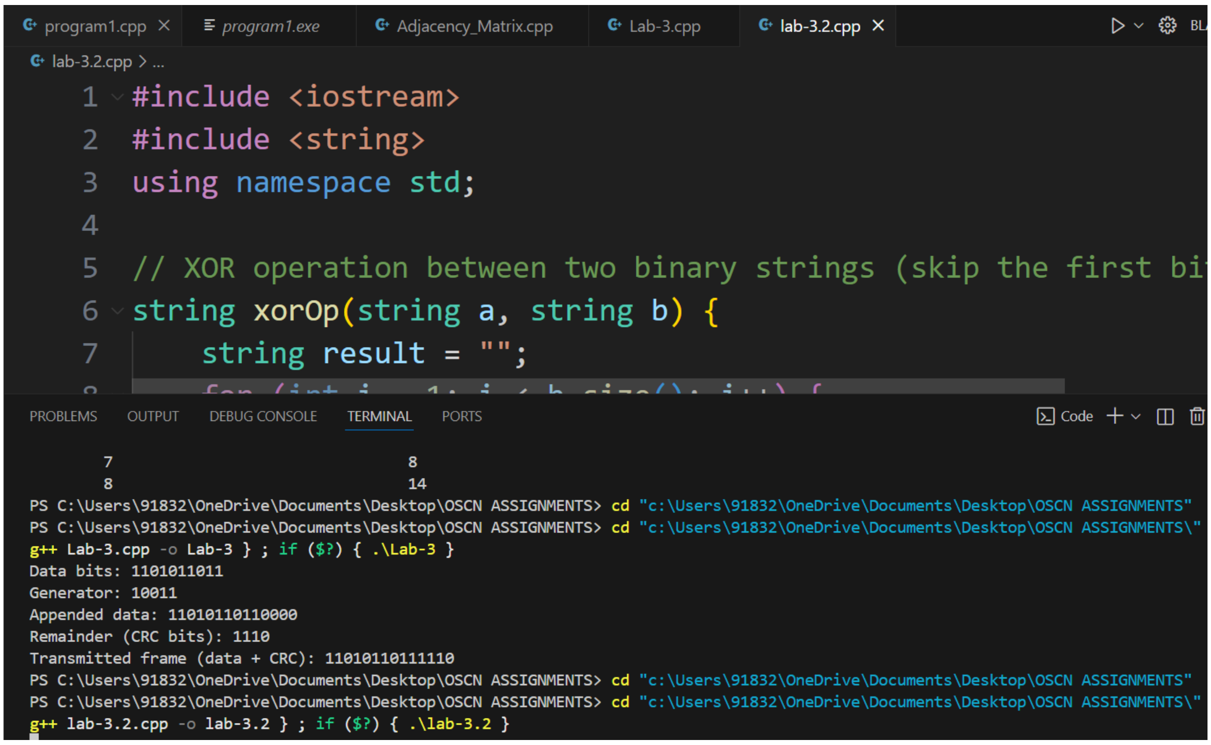
        isZero = false;
```

```
            break;
        }
    }

    if (isZero)
        cout << "Receiver: No error detected (remainder is zero)." << endl;
    else
        cout << "Receiver: Error detected (non-zero remainder)." << endl;

    return 0;
}
```

Output:



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Generator: 10011
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PS C:\Users\91832\OneDrive\Documents\Desktop\OSCN ASSIGNMENTS> cd "c:\Users\91832\OneDrive\Documents\Desktop\OSCN ASSIGNMENTS\"
g++ lab-3.2.cpp -o lab-3.2 } ; if ($?) { .\lab-3.2 }
```

1. Actual transmitted bit string: 10011101100

2. After 3rd bit inversion, receiver remainder = 100 → Error detected