**Title**: Finding integration of by numerical methods Trapezoidal Rule, Simpson’s 1/3-Rule & Simpson’s 3/8-Rule.

**Theoretical Background:**

Let the interval be divided into n equal subintervals such that Clearly, Hence the integral becomes,

On simplification,

**Trapezoidal Rule**: Setting and simplifying,

**Simpson’s 1/3-Rule:** Setting and simplifying,

**Simpson’s 3/8-Rule:** Setting and simplifying,

Program:

#include <iostream>

using namespace std;

double funk(double x)

{

    return 1 / (1 + x);

}

double integration(double h, int y, int a, int b)

{

    double n = ((b - a) / h), x = a, sum = funk(x);

    for (int i = 1; i <= n; i++)

    {

        if (y == 1)

        {

            x = x + h;

            cout << x << " " << funk(x) << endl;

            sum += 2 \* funk(x);

        }

        else if (y == 2)

        {

            if (i % 2 == 0)

            {

                x = x + h;

                cout << x << " " << funk(x) << endl;

                sum += 2 \* funk(x);

            }

            else if (i % 2 != 0)

            {

                x = x + h;

                cout << x << " " << funk(x) << endl;

                sum += 4 \* funk(x);

            }

        }

        else if (y == 3)

        {

            if (i % 3 == 0)

            {

                x = x + h;

                cout << x << " " << funk(x) << endl;

                sum += 2 \* funk(x);

            }

            else if (i % 3 != 0)

            {

                x = x + h;

                cout << x << " " << funk(x) << endl;

                sum += 3 \* funk(x);

            }

        }

    }

    if (y == 1)

        sum = (h / 2) \* (sum + funk(x + n));

    else if (y == 2)

        sum = (h / 3) \* (sum + funk(x + n));

    else if (y == 3)

        sum = (3 \* h / 8) \* (sum + funk(x + n));

    return sum;

}

int main()

{

    double h, a, b;

    cout << "enter the interval, LL, HL: ";

    cin >> h >> a >> b;

    double re = integration(h, 1, a, b);

    double re2 = integration(h, 2, a, b);

    double re3 = integration(h, 3, a, b);

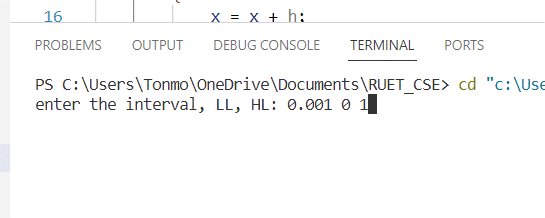
    cout << "The area value of 1/(1+x) by trapizoidal is = " << re << endl;

    cout << "The area value of 1/(1+x) by simpson's 1/3 rule is = " << re2 << endl;

    cout << "The area value of 1/(1+x) by simpson's 3/8 rule is = " << re3 << endl;

}

Input & Output:



A screenshot of a computer

Description automatically generated

**Discussion:** Numerical integration of the function using the Trapezoidal Rule, Simpson’s 1/3-Rule, and Simpson’s 3/8-Rule involves approximating the definite integral by dividing the interval into smaller segments. The Trapezoidal Rule calculates the area using trapezoids, while Simpson’s 1/3-Rule and 3/8-Rule utilize quadratic and cubic polynomial approximations, respectively. These methods improve accuracy compared to simple geometric shapes. The choice between them depends on the number of subintervals: Simpson’s 1/3-Rule requires an even number, while Simpson’s 3/8-Rule demands a multiple of 3. Adjusting the number of subintervals allows for a balance between computational efficiency and accuracy in estimating the integral.