**BS-3304L Numerical Analysis Lab**

**Simpson’s 1/3 Rule for Numerical Integration**

Simpson's 1/3 rule is a method for approximating the definite integral of a function over a given interval. It works by dividing the interval into two subintervals and approximating the integral over each subinterval using a quadratic polynomial.

The approximations for the two subintervals are then combined to give the overall approximation for the interval. The number of intervals and the interval width determine the accuracy of the integration.

You can increase the number of intervals to improve the accuracy, at the cost of increased computational time.

For the function, , shown in Figure 1, the definite integral within the limits and is,

The Simpson’s 1/3 rule approximates the function by , for which the integral is,

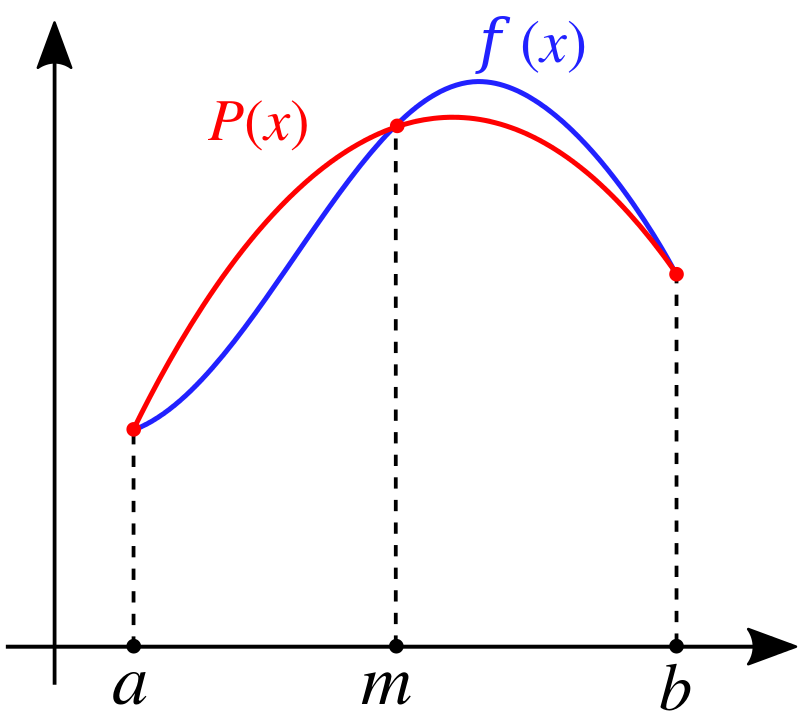


Figure 1

**Simpson’s 1/3 Rule Algorithm**

Here is the pseudo code for the Simpson’s 1/3 rule algorithm:

1. Define the function to be integrated, the limits of integration and , and the number of intervals . This needs to be done before the function for Simpson’s Rule.
2. Start a function for Simpson’s 1/3 Rule which takes and as input and returns the integral as the output. In the function:
   1. Set the interval width to be , where is the number of intervals.
   2. Initialize a variable sum to 0. This will be used to store the sum of the areas of the intervals.
   3. For each interval from to , do the following:
      1. Calculate the values at the start and end of the interval: and .
      2. Calculate the values at the start and end of the interval:
      3. Calculate the area of the parallelogram formed by the three points in the interval:
      4. Add the area of the interval to the sum: .
   4. Return the sum as the approximate value of the integral.

**Task 1**

Develop a MATLAB function for the Trapezoidal Rule.

The function should accept the following inputs:

1. Function handle
2. Function Limits
3. Number of divisions

The function should return the function integral as the output.

Write a script that uses the function to calculate the integral of between the limits and .

**Task 2**

Modify the function you wrote so that if accepts vectors of values of and points and calculates the integral.

**Code:**

|  |
| --- |
| clear all, clc    f = @ (x) x\*sin(x);    %a = 0;  disp('Enter lower bound limit')  a = input("Lower bound limit: ");    %b = pi;  disp('Enter upper bound limit')  b = input("Upper bound limit: ");    %N = 6;  disp('Enter number of intervals')  N = input("Enter intervals: ");    fprintf('\nThe solution using Simpsons 1/3rd Rule is: \n')  integral = simpson\_rule (f,a,b,N)    function sum = simpson\_rule (f,a,b,N)  sum = 0;    h = (b - a) / N;    for i = 1:N  x1 = a + ((i - 1) \* h);  x2 = a + (i \* h);    y1 = f(x1);  y2 = f(x1 + h/2);  y3 = f(x2);    area = (h/6) \* (y1 + y3 + 4\*y2);  sum = sum + area;    fprintf('Y: %.4f, Area: %.2f, Sum: %.4f\n', y1, area, sum)    end  end |

**Command Window Output:**

