Lab-6

# LAB 8: Computation of area under the curve using Trapezoidal, Simpson's $\left(\frac{1}{3}\right)^{\text{rd}}$ and Simpsons $\left(\frac{3}{8}\right)^{\text{th}}$ rule

## 8.1 Objectives:

## 8.2 Trapezoidal Rule

Evaluate $\int_{0}^{5} \frac{1}{1+x^2}$.

```
# Definition of the function to integrate
def my_func(x):
    return 1 / (1 + x ** 2)
```

```
# Function to implement trapezoidal method
def trapezoidal(x0, xn, n):
  h = (xn - x0) / n                                  # Calculating step
                                          size
  # Finding sum
  integration = my_func(x0) + my_func(xn)            # Adding first and
                                          last terms
  for i in range(1, n):
    k = x0 + i * h                                   # i-th step value
    integration = integration + 2 * my_func(k)       # Adding areas of the
                                             trapezoids
  # Proportioning sum of trapezoid areas
  integration = integration * h / 2
  return integration
```

```
# Input section
lower_limit = float(input("Enter lower limit of integration: "))
upper_limit = float(input("Enter upper limit of integration: "))
sub_interval = int(input("Enter number of sub intervals: "))

# Call trapezoidal() method and get result
result = trapezoidal(lower_limit, upper_limit, sub_interval)

# Print result
print("Integration result by Trapezoidal method is: " , result)
```

```
Enter lower limit of integration: 0
Enter upper limit of integration: 5
Enter number of sub intervals: 10
Integration result by Trapezoidal method is:  1.3731040812301099
```

## 8.3 Simpson's $\left(\frac{1}{3}\right)^{\text{rd}}$ Rule

Evaluate $\int_0^5 \frac{1}{1+x^2}$.

```
# Definition of the function to integrate
def my_func(x):
    return 1 / (1 + x ** 2)
```

```
# Function to implement the Simpson's one-third rule

def simpson13(x0,xn,n):
  h = (xn - x0) / n                        # calculating step size
  # Finding sum
  integration = (my_func(x0) + my_func(xn))
  k = x0
  for i in range(1,n):
    if i%2 == 0:
      integration = integration + 4 * my_func(k)
    else:
      integration = integration + 2 * my_func(k)
    k += h
  # Finding final integration value
  integration = integration * h * (1/3)
  return integration

# Input section
lower_limit = float(input("Enter lower limit of integration: "))
upper_limit = float(input("Enter upper limit of integration: "))
sub_interval = int(input("Enter number of sub intervals: "))

# Call trapezoidal() method and get result
result = simpson13(lower_limit, upper_limit, sub_interval)
print("Integration result by Simpson's 1/3 method is: %0.6f" % (result)
)
```

```
Enter lower limit of integration: 0
Enter upper limit of integration: 5
Enter number of sub intervals: 100
Integration result by Simpson's 1/3 method is: 1.404120
```

## 8.4 Simpson's 3/8th rule

Evaluate $\int_0^6 \frac{1}{1+x^2}dx$ using Simpson's 3/8 th rule, taking 6 sub intervals

```
def simpsons_3_8_rule(f, a, b, n):
```

```python
    h = (b - a) / n
    s = f(a) + f(b)
    for i in range(1, n, 3):
        s += 3 * f(a + i * h)
    for i in range(3, n-1, 3):
        s += 3 * f(a + i * h)
    for i in range(2, n-2, 3):
        s += 2 * f(a + i * h)
    return s * 3 * h / 8

def f(x):
    return 1/(1+x**2) # function here

a = 0   # lower limit
b = 6 #  upper limit
n = 6 # number of sub intervals

result = simpsons_3_8_rule(f, a, b, n)
print('%3.5f'%result)
```

1.27631

```
1.27631
```

## 8.5 Exercise:

1. Evaluate the integral $\int_0^1 \frac{x^2}{1+x^3}dx$ using Simpson's $\frac{1}{3}$ rule.

   Ans: 0.23108

2. Use Simpson's $\frac{3}{8}$ rule to find $\int_0^{0.6} e^{-x^2}dx$ by taking seven ordinates.

   Ans: 0.5351

3. Evaluate using trapezoidal rule $\int_0^{\pi} sin^2 x dx$. Take $n = 6$.

   Ans: $\pi/2$

4. A solid of revolution is formed by rotating about the $x$-axis, the area between the $x$-axis, the lines $x = 0$ and $x = 1$, and a curve through the points with the following co-ordinates:

| x | y |
|---|---|
| 0.00 | 1.0000 |
| 0.25 | 0.9896 |
| 0.50 | 0.9589 |
| 0.75 | 0.9089 |
| 1.00 | 0.8415 |