## LAB 3: Computation of Area under the curve using Trapezoidal, Simpson's (1/3) rd and (3/8) th rule

Program 1: Program to evaluate the definite integral $\int_0^1 \frac{dx}{1+x^2}$ using trapezoidal rule.

```
from sympy import *
var("x")
f=1/(1+x**2)
x0=float(input("Enter the lower limit "))
xn=float(input("Enter the upper limit "))
n=int(input("Enter number of sub intervals "))
print("Value of the integration by regular method is %.3f"%integrate(f,(x,x0,xn)))
f=lambdify(x,f)
h=(xn-x0)/n
sum=0
for i in range(0,n+1):
    xi=x0+i*h
    print(f"x{i}=%.2f\t\tf(%.2f)=%.2f"%(xi,xi,f(xi)))
    if i==0 or i==n:
        sum=sum+f(xi)
    else:
        sum=sum+2*f(xi)
print("Value of the integral by Trapezoidal rule is %0.3f"%(sum*h/2))
```

Output

```
Enter the lower limit 0
Enter the upper limit 1
Enter number of sub intervals 6
Value of the integration by regular method is 0.785
x0=0.00         f(0.00)=1.00
x1=0.17         f(0.17)=0.97
x2=0.33         f(0.33)=0.90
x3=0.50         f(0.50)=0.80
x4=0.67         f(0.67)=0.69
x5=0.83         f(0.83)=0.59
x6=1.00         f(1.00)=0.50
Value of the integral by Trapezoidal rule is 0.784
```

Program 2: Program to evaluate the definite integral $\int_0^1 \frac{dx}{1+x^2}$ using Simpson's (1/3)rd rule.

```
import sys
from sympy import *
var("x")
f=1/(1+x**2)
x0=float(input("Enter the lower limit "))
xn=float(input("Enter the upper limit "))
n=int(input("Enter number of sub intervals "))
if n%2!=0:
    sys.exit("The value of n should be multiple of 2")
print("Value of the integration by regular method is %.3f"%integrate(f,(x,x0,xn)))
f=lambdify(x,f)
h=(xn-x0)/n
sum=0
```

```
for i in range(0,n+1):
    xi=x0+i*h
    print(f"x{i}=%.2f\t\tf(%.2f)=%.2f"%(xi,xi,f(xi)))
    if i==0 or i==n:
        sum=sum+f(xi)
    elif i%2==0:
        sum=sum+2*f(xi)
    else:
        sum=sum+4*f(xi)
print("Value of the integral by simpson's (1/3)rd rule is %0.3f"%(sum*h/3))
```

Output:

```
Enter the lower limit 0
Enter the upper limit 1
Enter number of sub intervals 6
Value of the integration by regular method is 0.785
x0=0.00         f(0.00)=1.00
x1=0.17         f(0.17)=0.97
x2=0.33         f(0.33)=0.90
x3=0.50         f(0.50)=0.80
x4=0.67         f(0.67)=0.69
x5=0.83         f(0.83)=0.59
x6=1.00         f(1.00)=0.50
Value of the integral by simpson's (1/3)rd rule is 0.785
```

Program 3: Program to evaluate the definite integral $\int_0^1 \frac{dx}{1+x^2}$ using Simpson's (3/8)th rule.

```
import sys
from sympy import *
var("x")
f=1/(1+x**2)
x0=float(input("Enter the lower limit "))
xn=float(input("Enter the upper limit "))
n=int(input("Enter number of sub intervals "))
if n%3!=0:
    sys.exit("The value of n should be multiple of 3")
print("Value of the integration by regular method is %.3f"%integrate(f,(x,x0,xn)))
f=lambdify(x,f)
h=(xn-x0)/n
sum=0
for i in range(0,n+1):
    xi=x0+i*h
    print(f"x{i}=%.2f\t\tf(%.2f)=%.2f"%(xi,xi,f(xi)))
    if i==0 or i==n:
        sum=sum+f(xi)
    elif i%3==0:
        sum=sum+2*f(xi)
    else:
        sum=sum+3*f(xi)
print("Value of the integral by simpson's (3/8)th rule is %0.3f"%(sum*3*h/8))
```

Output:

```
Enter the lower limit 0
Enter the upper limit 1
Enter number of sub intervals 6
Value of the integration by regular method is 0.785
x0=0.00         f(0.00)=1.00
x1=0.17         f(0.17)=0.97
x2=0.33         f(0.33)=0.90
x3=0.50         f(0.50)=0.80
x4=0.67         f(0.67)=0.69
x5=0.83         f(0.83)=0.59
x6=1.00         f(1.00)=0.50
Value of the integral by simpson's (3/8)th rule is 0.785
```

Exercise: Write python program for the following

1. Program to evaluate the following definite integrals using the trapezoidal rule

(a) $\int_{4}^{5.2} \log x\,dx$ with $n=6$ (b) $\int_{0}^{\pi} \sin\theta\,d\theta$ with $n=10$

(c) $\int_{0}^{\pi/2} \sqrt{\cos\theta}\,d\theta$ with $n=8$ (d) $\int_{0}^{1} e^{-x^2}\,dx$ with $n=10$

2. Program to evaluate the following definite integrals using Simpson's (1/3)rd rule.

(a) $\int_{4}^{5.2} \log x\,dx$ with $n=6$ (b) $\int_{0}^{\pi} \sin\theta\,d\theta$ with $n=10$

(c) $\int_{0}^{\pi/2} \sqrt{\cos\theta}\,d\theta$ with $n=8$ (d) $\int_{0}^{1} e^{-x^2}\,dx$ with $n=12$

3. Program to evaluate the following definite integrals using Simpson's (3/8)th rule.

(a) $\int_{4}^{5.2} \log x\,dx$ with $n=6$ (b) $\int_{0}^{\pi} \sin\theta\,d\theta$ with $n=9$

(c) $\int_{0}^{\pi/2} \sqrt{\cos\theta}\,d\theta$ with $n=9$ (d) $\int_{0}^{1} e^{-x^2}\,dx$ with $n=12$