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.

```
1 from sympy import *
 2 var("x")
 3 f=1/(1+x**2)
4 x0=float(input("Enter the lower limit "))
 5 xn=float(input("Enter the upper limit "))
 6 n=int(input("Enter number of sub intervals "))
 7 print("Value of the integration by regular method is %.3f"%integrate(f,(x,x0,xn)))
 8 f=lambdify(x,f)
9 h=(xn-x0)/n
10 sum=0
11 for i in range(0,n+1):
12
     xi=x0+i*h
     print(f"x{i}=%.2f\t\tf(%.2f)=%.2f"%(xi,xi,f(xi)))
13
14
      if i==0 or i==n:
15
           sum=sum+f(xi)
16
       else:
          sum=sum+2*f(xi)
18 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
              f(0.33)=0.90
x2=0.33
              f(0.50)=0.80
x3=0.50
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
```

```
14 for i in range(0,n+1):
      xi=x0+i*h
16
        print(f''x\{i\}=\%.2f\setminus t(\%.2f)=\%.2f''\%(xi,xi,f(xi)))
      if i==0 or i==n:
17
18
           sum=sum+f(xi)
      elif i%2==0:
19
20
           sum=sum+2*f(xi)
21
        else:
22
           sum=sum+4*f(xi)
23 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
             f(0.00)=1.00
              f(0.17)=0.97
x1=0.17
              f(0.33)=0.90
x2=0.33
x3=0.50
              f(0.50)=0.80
              f(0.67)=0.69
x4=0.67
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.

```
1 import sys
 2 from sympy import *
3 var("x")
4 f=1/(1+x**2)
5 x0=float(input("Enter the lower limit "))
6 xn=float(input("Enter the upper limit "))
7 | n=int(input("Enter number of sub intervals "))
8 if n%3!=0:
       sys.exit("The value of n should be multiple of 3")
10 print("Value of the integration by regular method is %.3f"%integrate(f,(x,x0,xn)))
11 f=lambdify(x,f)
12 h=(xn-x0)/n
13 sum=0
14 for i in range(0,n+1):
15
      xi=x0+i*h
16
       print(f"x{i}=%.2f\t\tf(%.2f)=%.2f"%(xi,xi,f(xi)))
17
       if i==0 or i==n:
18
           sum=sum+f(xi)
       elif i%3==0:
19
20
           sum=sum+2*f(xi)
21
       else:
22
           sum=sum+3*f(xi)
23 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) $\int_{2}^{\pi/2} \sqrt{\cos \theta} \, d\theta$ 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)
$$\int_{4}^{5.2} \log x \, dx \text{ with } n = 6$$
(b)
$$\int_{0}^{\pi} \sin \theta \, d\theta \text{ with } n = 10$$
(c)
$$\int_{0}^{\pi/2} \sqrt{\cos \theta} \, d\theta \text{ with } n = 8$$
(d)
$$\int_{0}^{1} e^{-x^{2}} \, dx \text{ with } n = 12$$

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

(a)
$$\int_{4}^{5.2} \log x \, dx \text{ with } n = 6$$
(b)
$$\int_{0}^{\pi} \sin \theta \, d\theta \text{ with } n = 9$$
(c)
$$\int_{0}^{\pi/2} \sqrt{\cos \theta} \, d\theta \text{ with } n = 9$$
(d)
$$\int_{0}^{1} e^{-x^{2}} \, dx \text{ with } n = 12$$