Assignment on

Numerical Methods

Assignment topic: C code using numerical methods

Course Code: CSE 234
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Contents:

Bisection Method:

The **Bisection Method** is a numerical method for estimating the roots of a polynomial **f(x).** It is one of the simplest and most reliable but it is not the fastest method.

Problem: Here we have to find root for the polynomial x^3+x^2-1

Algorithm:

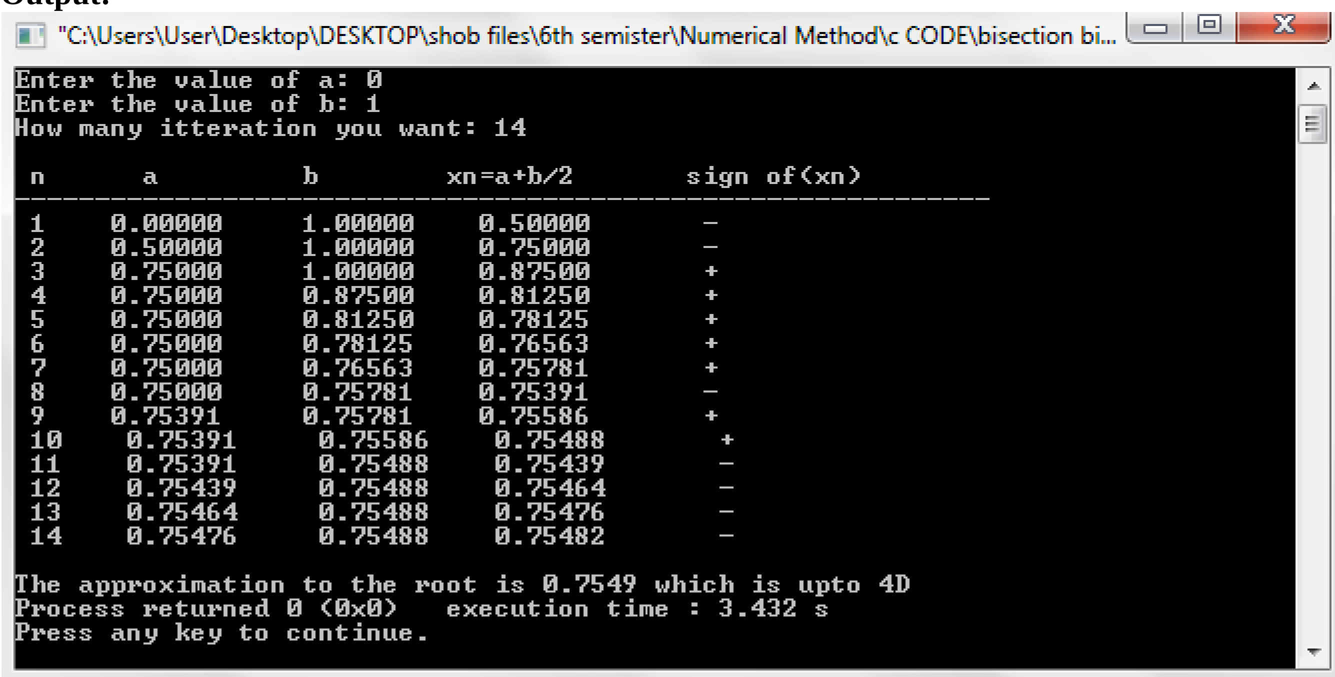
1. Start
2. Read a1, b1, TOL
   *Here a1 and b1 are initial guesses
   TOL is the absolute error or tolerance i.e. the desired degree of accuracy*
3. Compute: f1 = f(a1) and f3 = f(b1)
4. If (f1*f3) > 0, then display initial guesses are wrong and goto step 11
   Otherwise continue.
5. root = (a1 + b1)/2
6. If [(a1 – b1)/root] < TOL , then display root and goto step 11
   * Here [ ] refers to the modulus sign. *
   or f(root)=0 then display root
7. Else, f2 = f(root)
8. If (f1*f2) < 0, then b1=root
9. Else if (f2*f3)<0 then a1=root
10. else goto step 5
    Now the loop continues with new values.
11. Stop

Code:

```
#include<stdio.h>
#include<math.h>
#define f(y)  (pow(x,3)+x*x-1);
int main()
{
    double a,b,m=-1,x,y;
    int n=0,k,i;
    printf("Enter the value of a: ");
    scanf("%lf",&a);
    printf("Enter the value of b: ");
    scanf("%lf",&b);
    printf("How many itteration you want: ");
   scanf("%d",&k);
   printf("\n n      a         b        xn=a+b/2       sign of(xn)\n");
   printf("------------------------------------------------------------\n");
   for(i=1;i<=k;i++)
   {
        x=(a+b)/2;
        y=f(x);
```

```
        if(m==x)
        {
           break;
        }
        if(y>=0)
        {
            printf(" %d    %.5lf     %.5lf    %.5lf       +\n",i,a,b,x);
           b=x;
        }
        else if(y<0)
        {
            printf(" %d    %.5lf     %.5lf    %.5lf       -\n",i,a,b,x);
           a=x;
        }
         m=x;
    }
    printf("\nThe approximation to the root is %.4lf which is upto 4D",b);

    return 0;
}
```

Output:



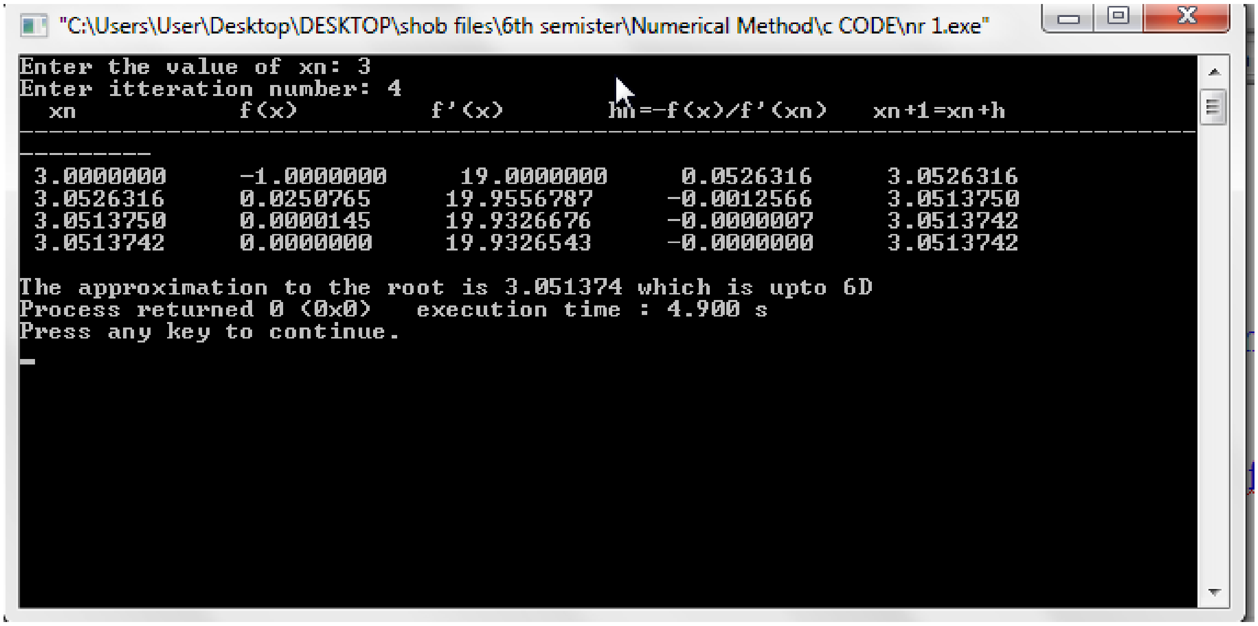
```
"C:\Users\User\Desktop\DESKTOP\shob files\6th semister\Numerical Method\c CODE\bisection bi...
Enter the value of a: 0
Enter the value of b: 1
How many itteration you want: 14

 n       a          b         xn=a+b/2       sign of(xn)
-------------------------------------------------------------
 1     0.00000     1.00000    0.50000        -
 2     0.50000     1.00000    0.75000        -
 3     0.75000     1.00000    0.87500        +
 4     0.75000     0.87500    0.81250        +
 5     0.75000     0.81250    0.78125        +
 6     0.75000     0.78125    0.76563        +
 7     0.75000     0.76563    0.75781        +
 8     0.75000     0.75781    0.75391        -
 9     0.75391     0.75781    0.75586        +
 10     0.75391     0.75586    0.75488        +
 11     0.75391     0.75488    0.75439        -
 12     0.75439     0.75488    0.75464        -
 13     0.75464     0.75488    0.75476        -
 14     0.75476     0.75488    0.75482        -

The approximation to the root is 0.7549 which is upto 4D
Process returned 0 (0x0)   execution time : 3.432 s
Press any key to continue.
```

Newton – Raphson Method:

Problem: Here we have to find root for the polynomial x^3-8*x-4 upto 6D(decimal places)

Solution in C:

```
#include<stdio.h>
#include<math.h>
#define f(x) pow(a,3)-8*a-4;
#define fd(x) 3*pow(a,2)-8;
int main()
{
    double a,b,c,d,h,k,x,y;
    int i,j,m,n;
    printf("Enter the value of xn: ");
    scanf("%lf",&a);
    printf("Enter itteration number: ");
    scanf("%d",&n);
    printf("  xn           f(x)          f'(x)        hn=-f(x)/f'(xn)   xn+1=xn+h\n");
    printf("------------------------------------------------------------------------------------------\n");
    for(i=1;i<=n;i++)
    {
    x=f(a);
    y=fd(x);
    h=-(x/y);
    k=h+a;
    printf(" %.7lf     %.7lf     %.7lf     %.7lf     %.7lf\n",a,x,y,h,k);
a=k;
    }
     printf("\nThe approximation to the root is %.6lf which is upto 6D",k);
    return 0;

}
```



Newton Forward Interpolation:

Problem: The population of a town is given below as thousands
Year : 1891 1901 1911 1921 1931
Population : 46 66 81 93 101

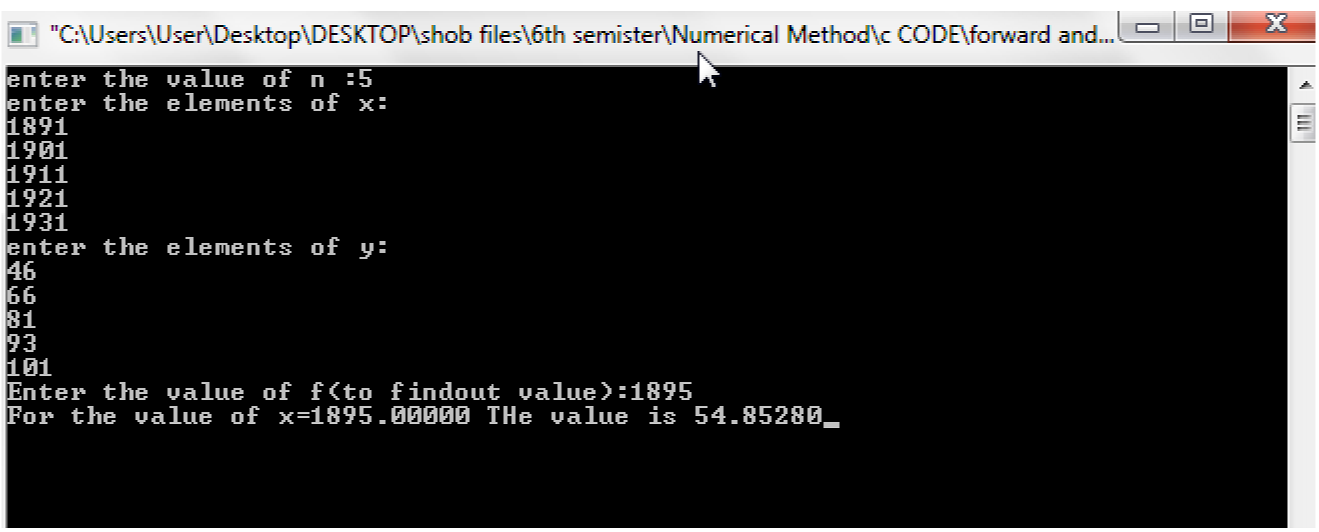
Find the population of 1895 ?

Code:

```
#include<stdio.h>
#include<math.h>
#include<stdlib.h>
main()
{
 float x[20],y[20],f,s,h,d,p;
 int j,i,n;
 printf("enter the value of n :");
 scanf("%d",&n);
 printf("enter the elements of x:");
 for(i=1;i<=n;i++)
  {
      scanf("\n%f",&x[i]);
       }
             printf("enter the elements of y:");
           for(i=1;i<=n;i++)
           {
```

```
        scanf("\n%f",&y[i]);
                }
 h=x[2]-x[1];
 printf("Enter the value of f(to findout value):");
 scanf("%f",&f);
s=(f-x[1])/h;
p=1;
d=y[1];
for(i=1;i<=(n-1);i++)
{
          for(j=1;j<=(n-i);j++)
          {
              y[j]=y[j+1]-y[j];

          }
          p=p*(s-i+1)/i;
          d=d+p*y[1];
}
printf("For the value of x=%6.5f THe value is %6.5f",f,d);
getch();
}
```

Output:



<u>Newton Backward Interpolation:</u>

Problem: The population of a town is given below as thousands

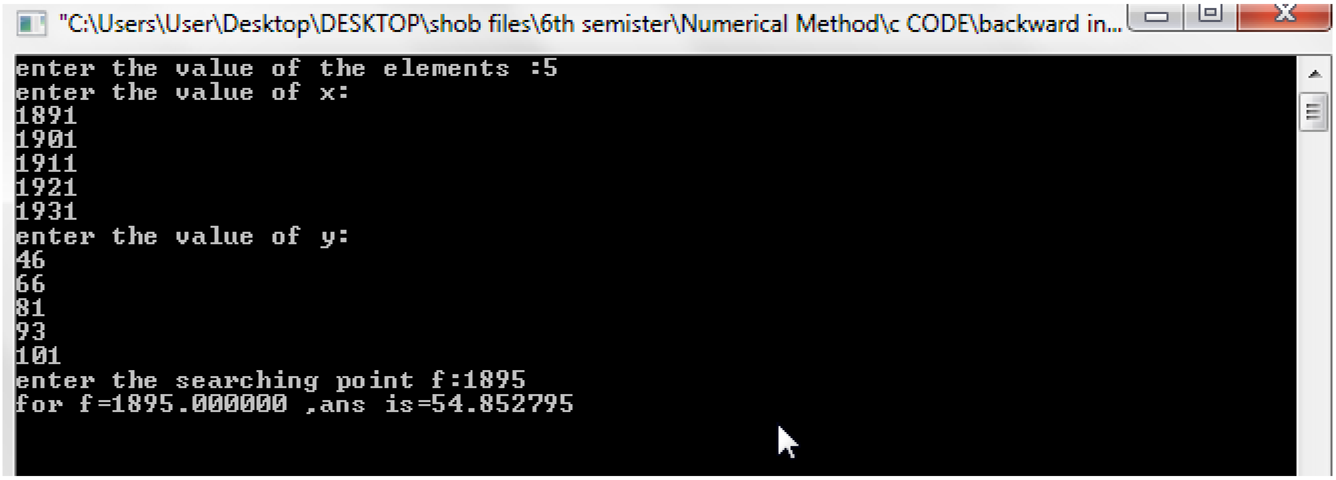
Year	: 1891	1901	1911	1921	1931
Population :	46	66	81	93	101

Find the population of 1895 ?

Code:

```
#include<stdio.h>
#include<math.h>
#include<stdlib.h>
main()
{
    float x[20],y[20],f,s,d,h,p;
    int j,i,k,n;
    printf("enter the value of the elements :");
    scanf("%d",&n);
    printf("enter the value of x:\n");
    for(i=1;i<=n;i++)
    {
            scanf("%f",&x[i]);
            }
        printf("enter the value of y:\n");
    for(i=1;i<=n;i++)
    {
            scanf("%f",&y[i]);
            }
            h=x[2]-x[1];
        printf("enter the searching point f:");
scanf("%f",&f);
s=(f-x[n])/h;
d=y[n];
p=1;
for(i=n,k=1;i>=1,k<n;i--,k++)
{
        for(j=n;j>=1;j--)
        {
                y[j]=y[j]-y[j-1];
                }
                p=p*(s+k-1)/k;
                d=d+p*y[n];
}
printf("for f=%f ,ans is=%f",f,d);
getch();
}
```

Output:



```
"C:\Users\User\Desktop\DESKTOP\shob files\6th semister\Numerical Method\c CODE\backward in...
enter the value of the elements :5
enter the value of x:
1891
1901
1911
1921
1931
enter the value of y:
46
66
81
93
101
enter the searching point f:1895
for f=1895.000000 ,ans is=54.852795
```

Lagrange Method:

Problem: The population of a town is given below as thousands

Year : 1891 1901 1911 1921 1931

Population : 46 66 81 93 101

Find the population of 1895 ?

Code:

```
#include<stdio.h>
#include<math.h>
int main()
{
  float x[10],y[10],temp=1,f[10],sum,p;
  int i,n,j,k=0,c;

  printf("\nhow many record you will be enter: ");
  scanf("%d",&n);
  for(i=0; i<n; i++)
  {
   printf("\n\nenter the value of x%d: ",i);
   scanf("%f",&x[i]);
   printf("\n\nenter the value of f(x%d): ",i);
   scanf("%f",&y[i]);
  }
  printf("\n\nEnter X for finding f(x): ");
  scanf("%f",&p);

  for(i=0;i<n;i++)
  {
    temp = 1;
```

```
    k = i;
    for(j=0;j<n;j++)
    {
      if(k==j)
      {
        continue;
      }
      else
      {
        temp = temp * ((p-x[j])/(x[k]-x[j]));
      }
    }
    f[i]=y[i]*temp;
  }

  for(i=0;i<n;i++)
  {
     sum = sum + f[i];
  }
  printf("\n\n f(%.1f) = %f ",p,sum);
  getch();
}
```

```
how many record you will be enter: 5

enter the value of x0: 1891

enter the value of f(x0): 46

enter the value of x1: 1901

enter the value of f(x1): 66

enter the value of x2: 1911

enter the value of f(x2): 81

enter the value of x3: 1921

enter the value of f(x3): 93

enter the value of x4: 1931

enter the value of f(x4): 101

Enter X for finding f(x): 1895

 f(1895.0) = 54.852806 _
```

Trapezoidal Rule:

Problem: Here we have to find integration for the (1/1+x*x)dx with lower limit =0 to upper limit = 6

Algorithm:

Step 1: input a,b,number of interval n

Step 2:h=(b-a)/n

Step 3:sum=f(a)+f(b)

Step 4:If n=1,2,3,……i

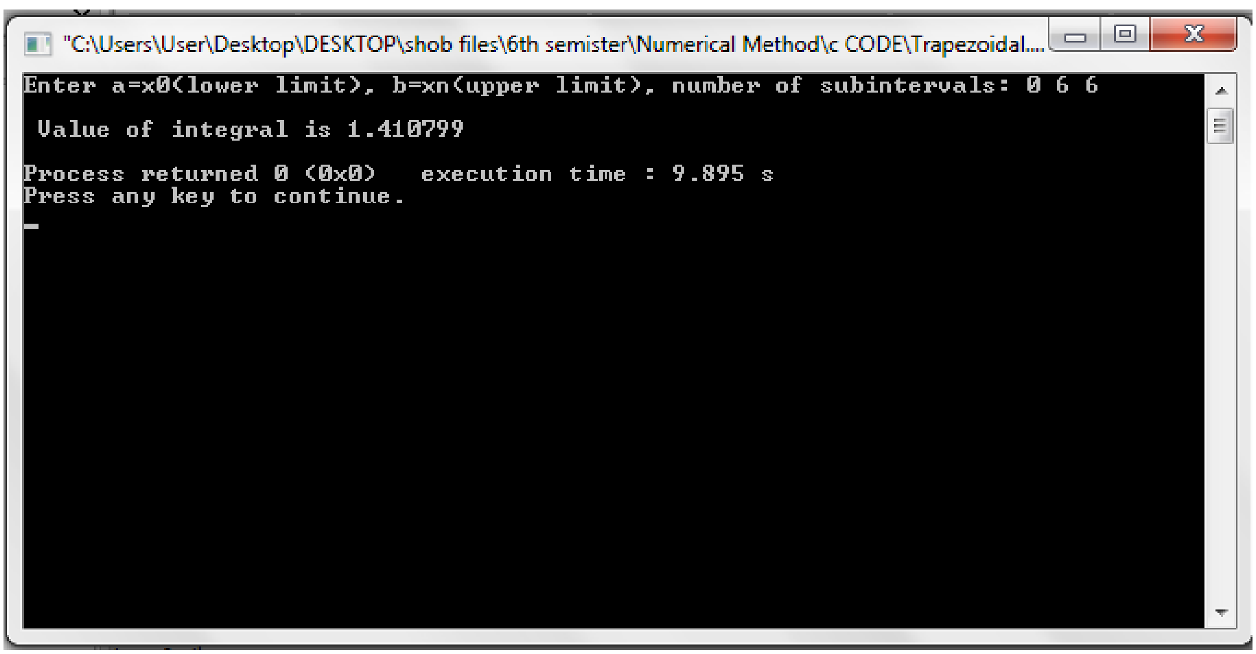
Then , sum=sum+2*y(a+i*h)

Step 5:Display output=sum *h/2

Code:

```c
#include<stdio.h>
float y(float x)
{
   return 1/(1+x*x);
}

int main()
{
   float a,b,h,sum;
   int i,n;

   printf("Enter a=x0(lower limit), b=xn(upper limit), number of subintervals: ");
   scanf("%f %f %d",&a,&b,&n);

   h=(b-a)/n;

   sum=y(a)+y(b);

   for(i=1;i<n;i++)
   {
      sum=sum+2*y(a+i*h);
   }

   printf("\n Value of integral is %f \n",(h/2)*sum);
   return 0;
}
```

Output:



Simpson’s 1/3 rule:

Problem: Here we have to find integration for the (1/1+x*x)dx with lower limit =0 to upper limit = 6

Algorithm:

Step 1: input a,b,number of interval n

Step 2:h=(b-a)/n

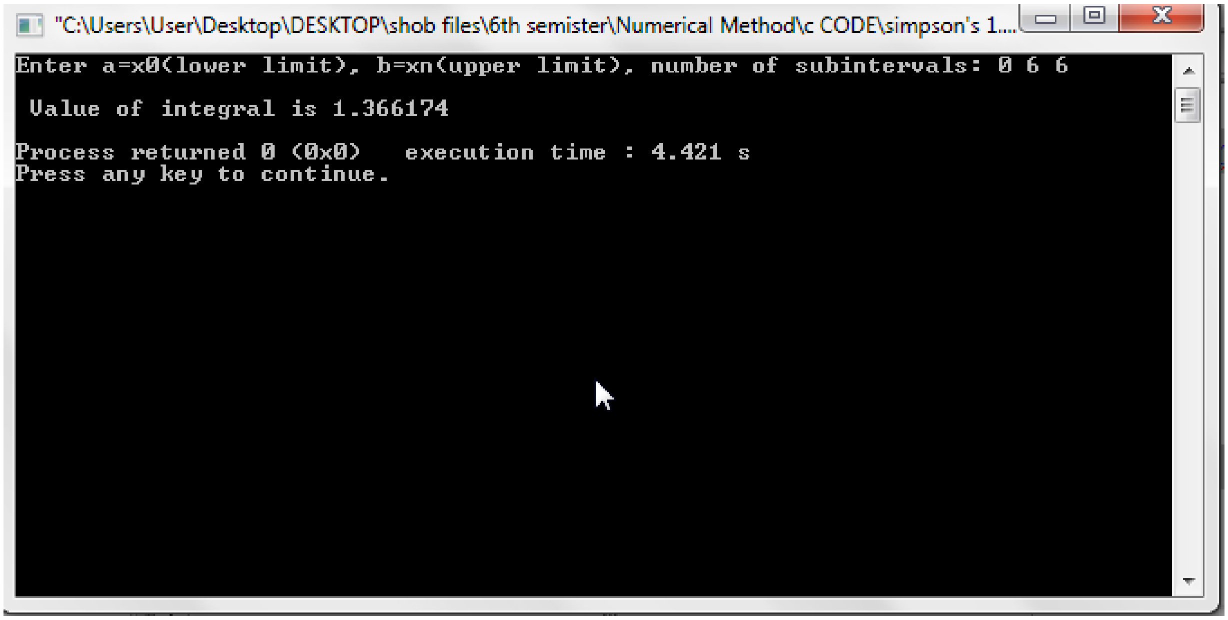
Step 3:sum=f(a)+f(b)+4*f(a+h)

Step 4:sum=sum+4*f(a+i*h)+2*f(a+(i-1)*h)

Step 5:Display output=sum * h/3

Code:

```c
#include<stdio.h>
float y(float x){
   return 1/(1+x*x);
}
int main(){
   float a,b,h,sum;
   int i,n;
   printf("Enter a=x0(lower limit), b=xn(upper limit), number of subintervals: ");
   scanf("%f%f%d",&a,&b,&n);
   h = (b - a)/n;
   sum = y(a)+y(b)+4*y(a+h);
   for(i = 3; i<=n-1; i=i+2){
      sum=sum+4*y(a+i*h) + 2*y(a+(i-1)*h);
   }
   printf("\n Value of integral is %f\n",(h/3)*sum);
   return 0;
}
```



<u>Simpson’s 3/8 rule:</u>

Problem: Here we have to find integration for the (1/1+x*x)dx with lower limit =0 to upper limit = 6

Algorithm:

Step 1: input a,b,number of interval n

Step 2:h=(b-a)/n

Step 3:sum=f(a)+f(b)

Step 4:If n is odd

Then , sum=sum+2*y(a+i*h)

Step 5: else, When   n I s even
Then, Sum = sum+3*y(a+i*h)

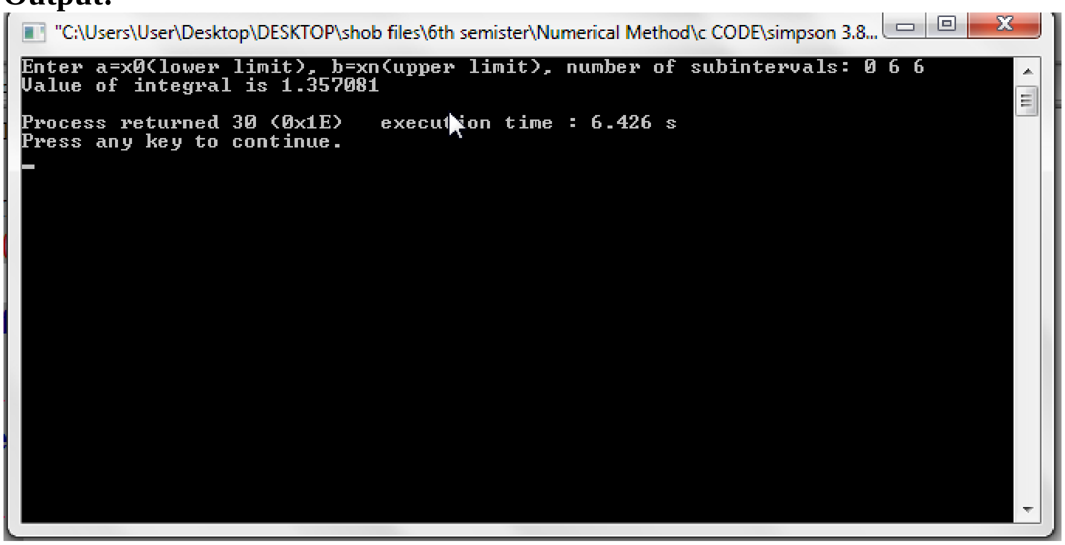
Step 6:Display output=sum *3* h/8

Code:

```
#include<stdio.h>
float y(float x){
    return 1/(1+x*x); //function of which integration is to be calculated
 }
int main(){
```

```
float a,b,h,sum;
int i,n,j;
sum=0;
printf("Enter a=x0(lower limit), b=xn(upper limit), number of subintervals: ");
scanf("%f%f%d",&a,&b,&n);
h = (b-a)/n;
sum = y(a)+y(b);
for(i=1;i<n;i++)
{
   if(i%3==0){
      sum=sum+2*y(a+i*h);
   }
   else{
      sum=sum+3*y(a+i*h);
   }
   }
printf("Value of integral is %f\n", (3*h/8)*sum);
}
```

Output:



Weddle's Rule:

Problem: Here we have to find integration for the (1/1+x*x)dx with lower limit =0 to upper limit = 6

Algorithm:

Step 1: input a,b,number of interval n

Step 2:h=(b-a)/n

Step 3:If(n%6==0)

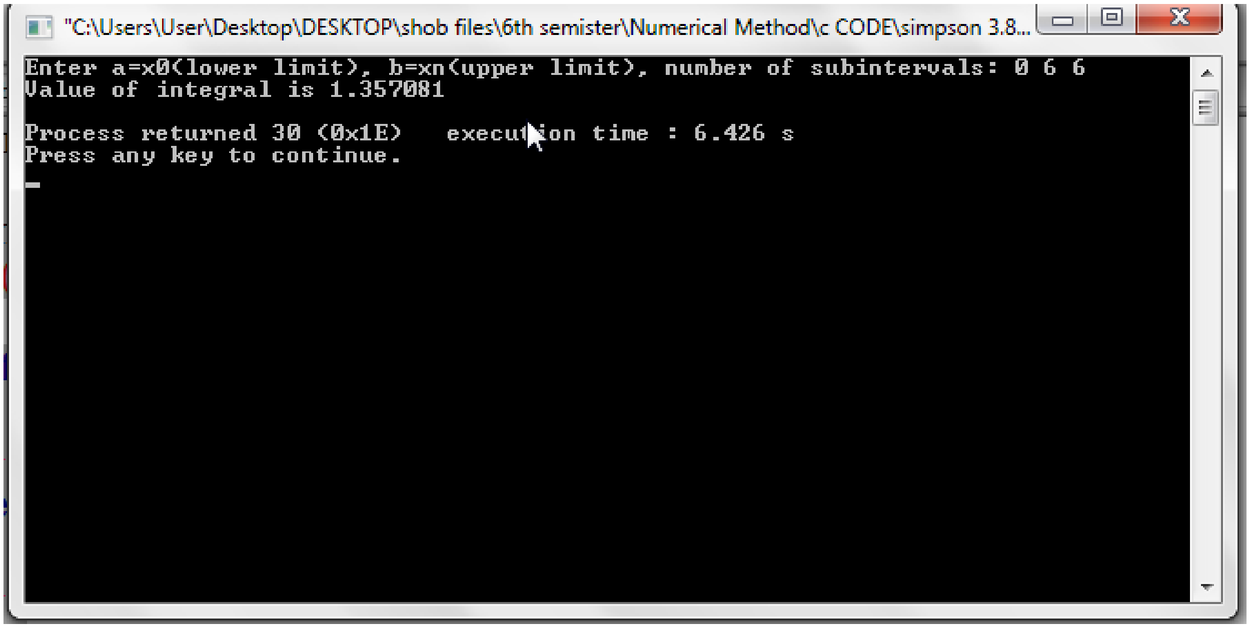
Then ,
sum=sum+((3*h/10)*(y(a)+y(a+2*h)+5*y(a+h)+6*y(a+3*h)+y(a+4*h)+5*y(a+5*h)+y(a+6*h)))
;
a=a+6*h
and Weddle’s rule is applicable then go to step 6

Step 4: else, Weddle’s rule is not applicable

Step 5:Display output

Code:

```
#include<stdio.h>
float y(float x){
    return 1/(1+x*x); //function of which integration is to be calculated
}
int main(){
    float a,b,h,sum;
    int i,n,m;

    printf("Enter a=x0(lower limit), b=xn(upper limit), number of subintervals: ");
    scanf("%f%f%d",&a,&b,&n);
    h = (b-a)/n;
    sum=0;

        if(n%6==0){
            sum=sum+((3*h/10)*(y(a)+y(a+2*h)+5*y(a+h)+6*=a+6*h;

        printf("Value of integral is %f\n", sum);
        }
        else{
            printf("Sorry ! Weddle rule is not applicable");
        }
    }
```



<u>Euler Method:</u>

Problem: Here we have to find dy/dx=x+y where y(0)=1 at the point x=0.05 and x=0.10 taking h=0.05

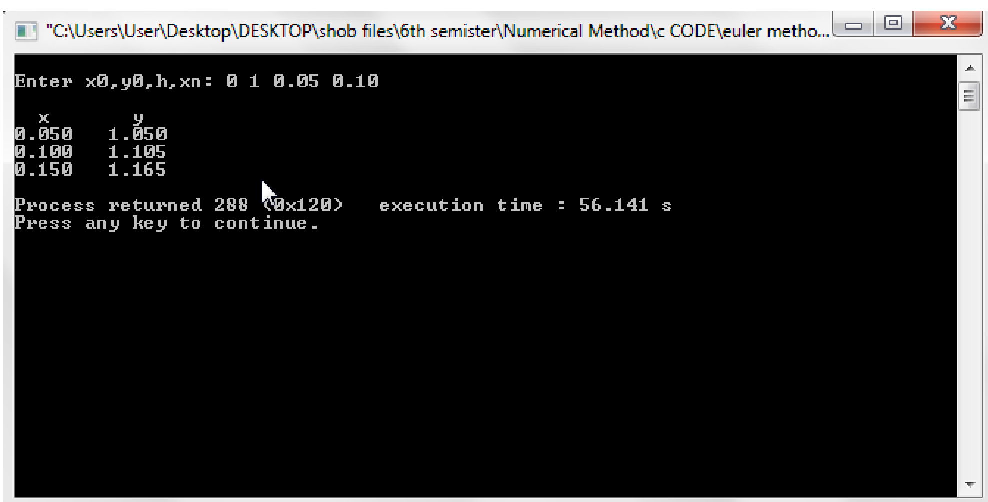
Algorithm:

1. Start
2. Define function
3. Get the values of x0, y0, h and xn
   *Here x0 and y0 are the initial conditions
   h is the interval
   xn is the required value
4. n = (xn – x0)/h + 1
5. Start loop from i=1 to n
6. y = y0 + h*f(x0,y0)
   x = x + h
7. Print values of y0 and x0
8. Check if x < xn
   If yes, assign x0 = x and y0 = y
   If no, goto 9.
9. End loop i
10. Stop

Code:

```c
#include<stdio.h>
float fun(float x,float y)
{
   float f;
   f=x+y;
   return f;
}
main()
{
   float a,b,x,y,h,t,k;
   printf("\nEnter x0,y0,h,xn: ");
   scanf("%f%f%f%f",&a,&b,&h,&t);
   x=a;
   y=b;
   printf("\n  x\t  y\n");
   while(x<=t)
   {
      k=h*fun(x,y);
      y=y+k;
      x=x+h;
      printf("%0.3f\t %0.3f\n",x,y);
   }
}
```

Output:



Runge-Kutta 4^{th} order method:

Problem: Here we have to find y(0,2) and y(0,4), Given dy/dx=1+y^2 where y=0 when x=0

Algorithm:

Step 1: input x0,y0,h,last point n

Step 2:m1=f(xi,yi)

Step 3:m2=f(xi+h/2,yi+m1h/2)

Step 4:m3=f(xi+h/2,yi+m2h/2)

Step 5:m4=f(xi+h,yi+m3h)

Step 6:yi+1=yi+(m1+2m2+2m3+m4/6)h

Step 5:Display output

Code:

```
#include<stdio.h>
#include <math.h>
#include<conio.h>
#define F(x,y)  1 + (y)*(y)
void main()
{
    double y0,x0,y1,n,h,f,k1,k2,k3,k4;
    system("cls");
    printf("\nEnter the value of x0: ");
    scanf("%lf",&x0);
    printf("\nEnter the value of y0: ");
    scanf("%lf",&y0);
    printf("\nEnter the value of h: ");
    scanf("%lf",&h);
    printf("\nEnter the value of last point: ");
    scanf("%lf",&n);
    for(; x0<n; x0=x0+h)
    {
        f=F(x0,y0);
        k1 = h * f;
        f = F(x0+h/2,y0+k1/2);
        k2 = h * f;
        f = F(x0+h/2,y0+k2/2);
        k3 = h * f;
        f = F(x0+h/2,y0+k2/2);
        k4 = h * f;
```

```
        y1 = y0 + ( k1 + 2*k2 + 2*k3 + k4)/6;
        printf("\n\n  k1 = %.4lf  ",k1);
        printf("\n\n  k2 = %.4lf ",k2);
        printf("\n\n  k3 = %.4lf ",k3);
        printf("\n\n  k4 = %.4lf ",k4);
        printf("\n\n  y(%.4lf) = %.3lf ",x0+h,y1);
        y0=y1;
    }
    getch();
}
```

Output:

```
"C:\Users\User\Desktop\DESKTOP\shob files\6th semister\Numerical Method\c CODE\runge from ...
Enter the value of y0: 0

Enter the value of h: 0.2

Enter the value of last point: 0.4


  k1 = 0.2000

  k2 = 0.2020

  k3 = 0.2020

  k4 = 0.2020

  y(0.2000) = 0.202

  k1 = 0.2081

  k2 = 0.2187

  k3 = 0.2193

  k4 = 0.2193

  y(0.4000) = 0.419 _
```

Gauss Seidel Method

Problem: Solve the following systems using gauss seidel method
5×1-x2-x3-x4=-4
-x1+10×2-x3-x4=12
-x1-x2+5×3-x4=8
-x1-x2-x3+10×4=34

Code:

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
```

```
#define acc 0.0001
#define X1(x2,x3,x4) ((x2 + x3 + x4 -4)/5)
#define X2(x1,x3,x4) ((x1 + x3 + x4 +12)/10)
#define X3(x1,x2,x4) ((x1 + x2 + x4 +8)/5)
#define X4(x1,x2,x3) ((x1 + x2 + x3 +34)/10)

void main()
{
  double x1=0,x2=0,x3=0,x4=0,y1,y2,y3,y4;
  int i=0;
  system("cls");
  printf("\n____________________________________________________________\n");
  printf("\n   x1\t\t   x2\t\t   x3\t\t    x4\n");
  printf("\n____________________________________________________________\n");
  printf("\n%f\t%f\t%f\t%f",x1,x2,x3,x4);
  do
  {
   y1=X1(x2,x3,x4);
   y2=X2(x1,x3,x4);
   y3=X3(x1,x2,x4);
   y4=X4(x1,x2,x3);
   if(fabs(y1-x1)<acc && fabs(y2-x2)<acc && fabs(y3-x3)<acc &&fabs(y4-x4) )
   {
     printf("\n____________________________________________________________\n");
     printf("\n\nx1 = %.3lf",y1);
     printf("\n\nx2 = %.3lf",y2);
     printf("\n\nx3 = %.3lf",y3);
     printf("\n\nx4= %.3lf",y4);
     i = 1;
   }
   else
   {
     x1 = y1;
     x2 = y2;
     x3 = y3;
     x4 = y4;
     printf("\n%f\t%f\t%f\t%f",x1,x2,x3,x4);
   }
  }while(i != 1);
getch();
}
```

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```
    x1                x2                x3                x4

0.000000          0.000000          0.000000          0.000000
-0.800000         1.200000          1.600000          3.400000
0.440000          1.620000          2.360000          3.600000
0.716000          1.840000          2.732000          3.842000
0.882800          1.929000          2.879600          3.928800
0.947480          1.969120          2.948120          3.969140
0.977276          1.986474          2.977148          3.986472
0.990019          1.994090          2.990044          3.994090
0.995645          1.997415          2.995640          3.997415
0.998094          1.998870          2.998095          3.998870
0.999167          1.999506          2.999167          3.999506
0.999636          1.999784          2.999636          3.999784
0.999841          1.999906          2.999841          3.999906

x1  = 1.000

x2  = 2.000

x3  = 3.000

x4= 4.000
```