

PROGRAM STATEMENT: Given $dy/dx=x+y$, $y(0)=1$, compute $y(.1)$, by Euler's Modified Method taking step length $h=.05$, correct upto 4 decimal places

THEORY: Euler's method is simple and single-step but a crude numerical method for solving an ordinary initial value differential equation, where the solution will be obtained as a set of variables x and y .

Let us consider a first order and first degree differential eqn as:

$dy/dx=f(x,y)$, with $y(x_0)=y_0$.

Euler's general iteration formula is \Rightarrow

$$y_n = y_{n-1} + hf(x_{n-1}, y_{n-1}) = y(x_n)$$

where h is the difference between two intervals & $f(x,y)$ is the function of x & y and x_r is the r 'th value of x and y_r is the r 'th value of y .

And according to **Euler's modified method** we use the **Trapezoidal rule** in the range $[x_{r-1}, x_{r+1}]$, we get,

$$y_r^{(n)} = y_{(r+1)} + \frac{h}{2} [f(x_{r-1}, y_{r-1}) + f(x_r, y_r^{(n-1)})]$$

where $y_r^{(n)}$ is the n th approximation to $y_r^{(n)} \simeq y_r$.

PROGRAM CODE:

```
//C Program to Find Solution of Ordinary Differential Equation of 1st Order
by Euler's Modified Method
#include <stdio.h>
#include <math.h>
#define f(x,y) (x+y)
double error(int a)
{
    return 5*pow(10,-a-1);
}
double mod(double x)
{
    if(x<0)
        return -x;
    else
        return x;
}
int main()
{
    double x0,x,h,e,e1,y0,y1,y2,k0,k1;
    printf("f(x,y)=x+y\nEnter Value of x::");
    scanf("%lf",&x0);
    printf("Enter Value of y for x=%4.2lf::",x);
    scanf("%lf",&y0);
    printf("Enter Step length h::");
    scanf("%lf",&h);
    printf("Enter value of x for which y is to be computed::");
    scanf("%lf",&x);
    printf("You need the answer correct upto how many decimal places? ::");
    scanf("%lf",&e);
    e=error(e);
    printf("y(%4.2lf)=%.4lf\n",x0,y0);
    while(x0<x)
```

```

{
    k0=f(x0,y0);
    y1=y0+h*k0;
    e1=1;
    while(e1>e)
    {
        k1=f(x0+h,y1);
        y2=y0+h*(k0+k1)/2;
        e1=mod(y2-y1);
        y1=y2;
    }
    y0=y1;
    x0=x0+h;
    printf("y(%4.2lf)=%4.4lf\n",x0,y0);
}
return 0;
}

```

OUTPUT:

```

f(x,y)=x+y
Enter Value of x::0
Enter Value of y for x=0.00::1
Enter Step length h::.05
Enter value of x for which y is to be computed::.1
You need the answer correct upto how many decimal places? ::4
y(0.00)=1.0000
y(0.05)=1.0526
y(0.10)=1.1104

```