Jahangirnagar University
Department of Computer Science and Engineering

LAB REPORT
ON
CSE-206 (NUMERICAL METHODS LAB)

EXPERIMENT No.: 03

EXPERIMENT NAME: Determining the root of a non-linear equation using Newton-Raphson Method.

SUBMITTED BY			SUBMITTED TO
Sumaita Binte Shorif			**Dr. Md. Golam Moazzam**
Class Roll: 357			**Professor**
Exam Roll: 191338			**Dept. of Computer Science & Engineering**
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Name of the Experiment: Determining the root of a non-linear equation using Newton-Raphson Method.

Objectives:

- Understanding the process of finding the root of non-linear equation using Newton-Raphson Method.
- Executing the implementation of the algorithm of Newton-Raphson Method.
- To achieve the accurate root and expected output of a given nonlinear function.
- To be able to interpret the advantages and disadvantages of Newton-Raphson Method.

Theory:

Let us assume that x_1 is an approximate root of *f(x)* = 0. Now, a tangent at the curve *f(x)* at

x = x_1.

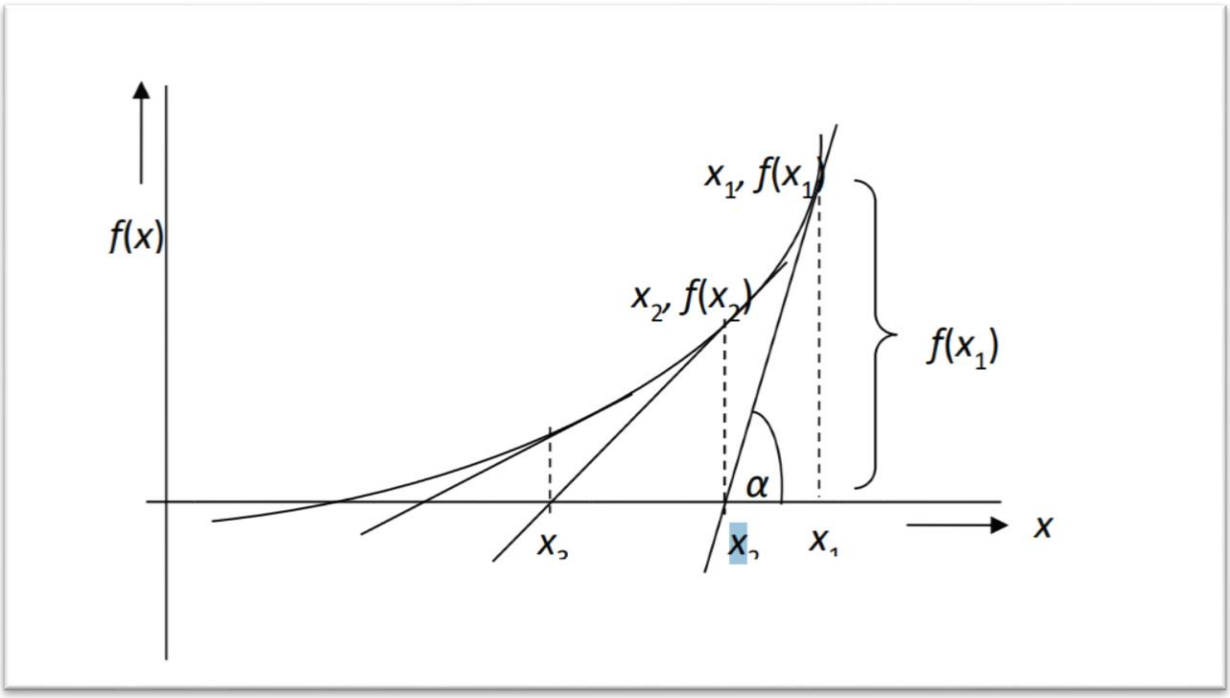

Fig 01: Graphical Depiction of Newton-Raphson Method.

The point of intersection of this tangent with the x-axis gives the second approximation to the root. Let the point of intersection be x_2.

The slope of the tangent is given by,

$$\tan \alpha = \frac{f(x_1)}{x_1 - x_2} = f'(x_1)$$

where $f'(x_1)$is the slope of *f(x)* at x = x_1. Solving for x_2 we obtain

$$x_2 = \frac{f(x_1)}{f'(x_1)}$$

This is called the Newton-Raphson formula.

The next approximation would be

$$x_3 = x_2 - \frac{f(x_2)}{f'(x_2)}$$

That is in general,

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

This method of successive approximation is called the Newton-Raphson method. The process will be terminated when the difference between two successive values is within a prescribed limit.

Algorithm:

Newton-Raphson Method:

1. Assign an initial value of x, say x_0.
2. Evaluate $f(x_0)$ and $f'(x_0)$.
3. Find the improved estimate of x_0

$$x_1 = x_0 - \frac{f(x_0)}{f'(x_0)}$$

4. Check the accuracy of the latest estimate.
   Compare relative error to a predefined value E.
   If $|\frac{x_1 - x_0}{x_{01}}| \leq E$ stop. Otherwise continue.
5. Replace x_0 by x_1 and repeat step 3 and step 4

Coding in C:

```
#include<stdio.h>
#include<math.h>
#define EPS 0.000001
#define MAXIT 20
#define F(x)  (x)*(x)-3*(x)+2
#define FD(x)  2*x-3
void New_Raph(float x0, float fx, float fdx, float xn, int count)
{
    count=1;
    while(1)
    {
        fx=F(x0);
        fdx=FD(x0);
        xn= x0-(fx / fdx);
        if((fabs(xn-x0)/ xn) <EPS)
        {
            printf("Root = %f\n",xn);
            printf("Function Value = %f\n",F(xn));
            printf("Number of Iterations = %d\n",count);
            break;
        }
        else
        {
            x0 = xn;
            count=count+1;
```

```c
            if(count<MAXIT)
            {
                continue;
            }
            else
            {
                printf("SOLUTION DOES NOT CONVERGE\n");
                printf("IN %d ITERATIONS\n",MAXIT);
            }
        }
    }
}
int main()
{
    int count;
    float x0,xn,fx,fdx;
    printf("The function is: x^2 - 3x +2\n");
    printf("Function derivative of first order is: 2x-3\n\n");
    printf("Input Initial value of x\n");
    scanf("%f",&x0);
    printf("\n");
    printf("SOLUTION BY NEWTON RAPHSON METHOD\n");
    printf("-------------------------------------\n");
    New_Raph(x0,fx,fdx,xn,count);
}
```

Output:

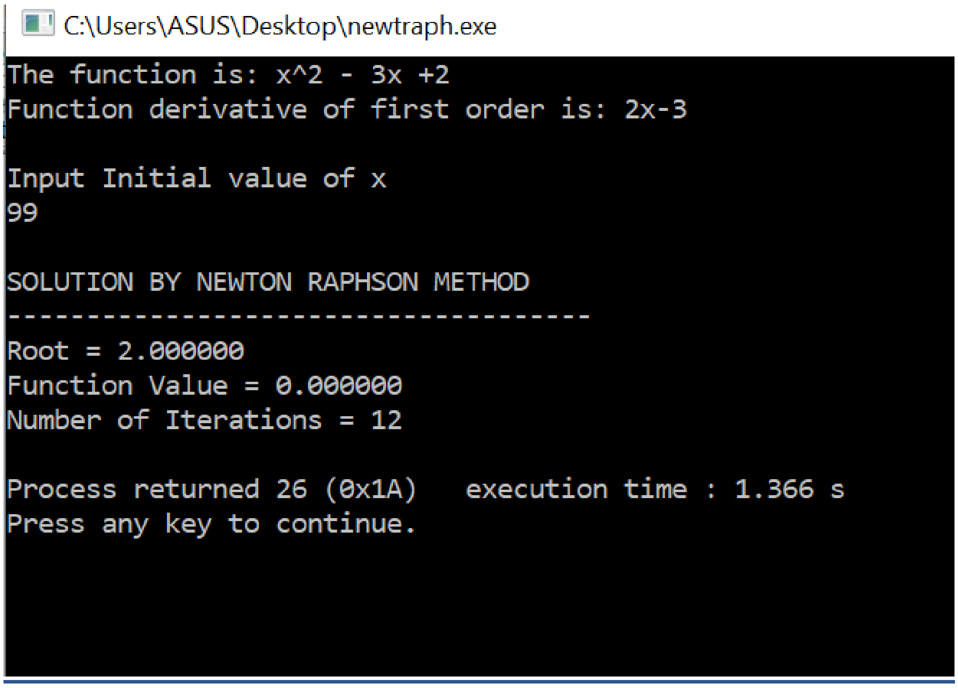

Fig 02: Output Obtained.

Discussion:

From the above experiment, we can observe that, complications will arise if the derivative is zero.

In such case, a new initial value for x must be chosen to continue the procedure. If the initial guess is too far away from the required root, the process may converge to some other root.

A particular value in the iteration sequence may repeat, resulting in an infinite loop. This occurs when the tangent to the curve $f(x)$ at $x = x_{i+1}$ cuts the x-axis again at $x = x_i$.

This method is much convenient for determining roots of a non-linear equation because this method converges quickly.
