**COMPUTER SCIENCE DEPARTMENT**

NUMERICAL COMPUTING

**Assignment # 02**

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# Submitted to: Dr. Sajjad Ahmed Ghauri

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**Question no.1**

Use a fix-point literation method to determine a solution accurate within 10-3 for

**Part A:**

**e-2x = 1.5x**

**Solution**

Case 1:

x = e-2x /1.5 => xn+1 = e-2x /1.5

Case 2:

-2x = ln (1.5x)

x = ln (1.5x)/-2 => xn+1 = ln (1.5x)/-2

we use xn+1 = e-2x /1.5 equation to solve our calculations

|  |  |  |  |
| --- | --- | --- | --- |
| **n** | **xn** | **xn+1** | **E** |
| 1 | 0 | 0.6667 |  |
| 2 | 0.6667 | 0.1757 | 275.45% |
| 3 | 0.1757 | 0.4691 | 62.55% |
| 4 | 0.4691 | 0.2609 | 79.80% |

As we see that the error rises so we stop our calculations at 4th literation of the equation.

**Part B:**

**x2 + 2x - 3 = 0 on [12,22] for xo = 15**

**Solution**

Case 1:

X2 = 3 – 2x

x = (3 – 2x)1/2  => xn+1 = (3 – 2x n)1/2

Case 2:

2x = 3 – x2

x = (3 – x2)/2 => xn+1 = (3 – x2n)/2

Case 3:

x (x + 2) – 3 = 0

x = 3/ (x – 2) => xn+1 = 3/ (x n – 2)

we use xn+1 = 3/ (x n – 2) equation to solve our calculations

|  |  |  |  |
| --- | --- | --- | --- |
| **n** | **Xn** | **Xn+1** | **En** |
| 1 | 15 | 0.1765 |  |
| 2 | 0.1765 | 1.3786 | 87.19% |
| 3 | 1.3786 | 0.888 | 55.22% |
| 4 | 0.888 | 1.0388 | 14.51% |
| 5 | 1.0388 | 0.9872 | 5.22% |
| 6 | 0.9872 | 1.0043 | 1.70% |
| 7 | 1.0043 | 0.9986 | 0.57% |
| 8 | 0.9986 | 1.0005 | 0.19% |
| 9 | 1.0005 | 0.9998 | 0.07% |
| 10 | 0.9998 | 1.0001 | 0.03% |
| 11 | 1.0001 | 1.0000 | 0.01% |
| 12 | 1 | 1 | 0% |

After the 12th iteration we get the 0% error in the equation.

**Question no.2**

Use a Newton Method to find root correct up to 3 decimal places

**Part A:**

**F(x) = x3 – 12 and x0 = 2**

**Solution**

F(x) = x3 – 12 ; xn+1 = xn – (F(x)/F’(x))

F’(x) = 3x2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **n** | **Xn** | **F(X)** | **F’(X)** | **Xn+1** | **Error** |
| 1 | 2 | -4 | 12 | 2.3333 |  |
| 2 | 2.3333 | 0.7032 | 16.3329 | 2.2902 | 1.8819% |
| 3 | 2.2902 | 0.0121 | 15.7350 | 2.2894 | 0.0349% |
| 4 | 2.2894 | -0.0004 | 15.7241 | 2.2894 | 0% |

After the 4rd iteration we get the 0% error in the equation.

**Part B:**

**F(x) = x2 – sin x and x0 = -0.5**

**Solution**

F(x) = x2 – sin x ; xn+1 = xn – (F(x)/F’(x))

F’(x) = 2x – cos x

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **n** | **Xn** | **F(X)** | **F’(X)** | **Xn+1** | **Error** |
| 1 | -0.5 | 0.7294 | -1.8776 | -0.115 |  |
| 2 | -0.1115 | 0.1237 | -1.2168 | -0.0098 | 10.52% |
| 3 | -0.0098 | -0.0098 | -1.0196 | -0.0001 | 0.97% |

After the 3rd iteration we get the 0.97% (almost, near to zero) error in the equation.

**Question no.3**

Use a Secant method & False Position method to find solution accurately to within 10-4 for the following problems.

X – cos x = 0, [0, π/2]

**Solution**

xn+1 = xn – [F(xn)(xn – xn-1) / F(xn) - F(xn+1)]

e = |(x2 – x1)/x2| \* 100

F(xn) = x - cos x // x0 = 0

// x1 = π/2 =1.5708

For **n=1**;

x2 = x1 – [F(x1)(x1 – x0) / F(x1) - F(x0)]

F(x0) = 0 – cos(0) = -1

F(x1) = 1.5708 – cos(1.5708) = 1.5708

Cheak

F(x1) \* F(x0) < 0

-1.5708 < 0 //condition TRUE

x2 = 1.5708 – [(1.5708)(1.5708-0) / (1.5708) – (-1)]

x2 = 0.6110

e = |(0.6110 -1.5708) / (0.6110)| \* 100

e = 157.09%

For **n=2**;

x3 = x2 – [F(x2)(x2 – x1) / F(x2) - F(x1)]

F(x2) = 0.6110 – cos(0.6110) = -0.2081

Cheak

F(x1) \* F(x0) < 0

-0.3269 < 0 //condition TRUE

x3 = -0.2081 – [(-0.2081)(-0.6110-1.5708) / (-0.2081) – (1.5708)]

x3 = 0.7233

e = |(0.7233 -0.6110) / (0.7233)| \* 100

e = 15.52%

For **n=3**;

x3 = x2 – [F(x2)(x2 – x1) / F(x2) - F(x1)]

F(x2) = 0.7233 – cos(0.7233) = 0.0623

Cheak

F(x1) \* F(x0) < 0

0.0054 < 0 //condition False

NOW Continue Secant Method

x4 = 0.7233 – [(-0.0263)(0.7233 -0.6110) / (-0.0263) – (-0.2081)]

x4 = 0.7395

e = |(0.7395 -0.7233) / (0.7395)| \* 100

e = 2.19 %

For **n=4**;

x5 = x4 – [F(x4)(x4 – x3) / F(x4) - F(x3)]

F(x4) = 0.7395– cos(0.7395) = 0.0006

x5 = 0.7395– [(0.0006)(0.7395-0.7233) / (0.0006) – (-0.0263)]

x5 = 0.7391

e = |(0.7391 -0.7395) / (0.7391)| \* 100

e = 0.05%

For **n=5**;

x6 = x5 – [F(x5)(x5 – x4) / F(x5) - F(x4)]

F(x5) = 0.7391– cos(0.7391) = 0.0002

x6 = 0.7391– [(0.0002)(0.7391-0.7395) / (0.0002) – (0.0006)]

x6 = 0.7390

e = |(0.7390 -0.7391) / (0.7390)| \* 100

e = 0.02%

For **n=6**;

x7 = x6 – [F(x6)(x6 – x5) / F(x6) - F(x5)]

F(x6) = 0.7390– cos(0.7390) = -0.0001

x7 = 0.7391– [(-0.0001)(0.7390-0.7391) / (-0.0001) – (0.0001)]

x7 = 0.7391

e = |(0.7391 -0.7390) / (0.7391)| \* 100

e = 0.02%

After the 6th iteration we get the 0.02% (almost, near to zero) error in the equation.

**Question no.4**

Write a computer program for any of the above equation

1. MATLAB
2. Python
3. C/C++
4. java

**Solution:**

**Code**

#include<iostream>

#include<cmath>

#include<iomanip>

using namespace std;

int main()

{

    float x=2;

    float F\_X  = (pow(x,3))-12;

    float FF\_X = (3\*pow(x,2));

    float e;

    float X1=x-(F\_X/FF\_X);

    cout<<"  ---------------------------------------------------------------------------------------------------------------"<<endl;

    cout<<"  | n  |\tXn \t|\t F(x) \t\t|\t FF(x)\t \t|\t Xn+1\t  |\t\tE\t|"<<endl;

    cout<<"  ---------------------------------------------------------------------------------------------------------------"<<endl;

    for(int i=0 ; i<10 ; i++)

    {

        F\_X  = (pow(x,3))-12;

        FF\_X = (3\*pow(x,2));

        X1=x-(F\_X/FF\_X);

        if(x == X1)

        {

            break;

        }

        cout<<setprecision(7)<<"  | "<<i+1<<"  |"<<setw(12)<<x<<"\t|\t"<<setw(12)<<setprecision(7)<<F\_X<<"\t|\t"<<setw(12)<<FF\_X<<"\t|\t"<<X1<<

        "  |";

        if(i>0)

        {

            e=x-X1;

            cout<<setprecision(7)<<"\t"<<setw(12)<<e<<"\t|";

        }

        else

        {

            cout<<"\t\t\t|";

        }

        cout<<endl;

        x=X1;

    }

    cout<<"  ---------------------------------------------------------------------------------------------------------------"<<endl;

}

**Output**

