CEN 103

HIMANSHU KUMAR

21113063

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Assignment - 10

Himanshu kumar
21113063

P1)

a) $f(x) = x - 2\sin x$

$f'(x) = 1 - 2\cos x$

$x_0 = 1.1$ $\quad\quad x_{n+1} = x_n - \frac{f(x_0)}{f'(x_0)}$

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

$= 1.1 - \frac{(1.1 - 2\sin 1.1)}{1 - 2\cos(1.1)}$

$= 8.45299$

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

$= 8.45299 - \left(\frac{8.45299 - 2\sin(8.45299)}{1 - 2\cos(8.45299)}\right)$

$x_2 = 5.25641$

$x_3 = 5.25641 - \left(\frac{5.25641 - 2\sin(5.25641)}{1 - 2\cos(5.25641)}\right)$

$= 203.384$

$x_4 = 203.384 - \left(\frac{203.384 - 2\sin(203.384)}{1 - 2\cos(203.384)}\right)$

$= 118.019$

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$$x_5 = 118.019 - \left(\frac{118.019 - 2\sin(118.019)}{1 - 2\cos(118.019)}\right)$$
$$= -87.4709$$

$$x_6 = -87.4709 - \left(\frac{-87.4709 - 2\sin(-87.4709)}{1 - 2\cos(-87.4709)}\right)$$
$$= -203.636$$

After 6 iterations we got -203.636.

b) for $x_0 = 1.5$

$$x_1 = 1.5 - \left(\frac{1.5 - 2\sin(1.5)}{1 - 2\cos(1.5)}\right)$$
$$= 2.07656$$

$$x_2 = 2.07656$$
$$= 2.07656 - \left(\frac{2.07656 - 2\sin(2.07656)}{1 - 2\cos(2.07656)}\right)$$
$$= 1.91051$$

$$x_3 = 1.91051 - \left(\frac{1.91051 - 2\sin(1.91051)}{1 - 2\cos(1.91051)}\right)$$
$$= 1.89562$$

$$x_4 = 1.89562 - \left(\frac{1.89562 - 2\sin(1.89562)}{1 - 2\cos(1.89562)}\right)$$

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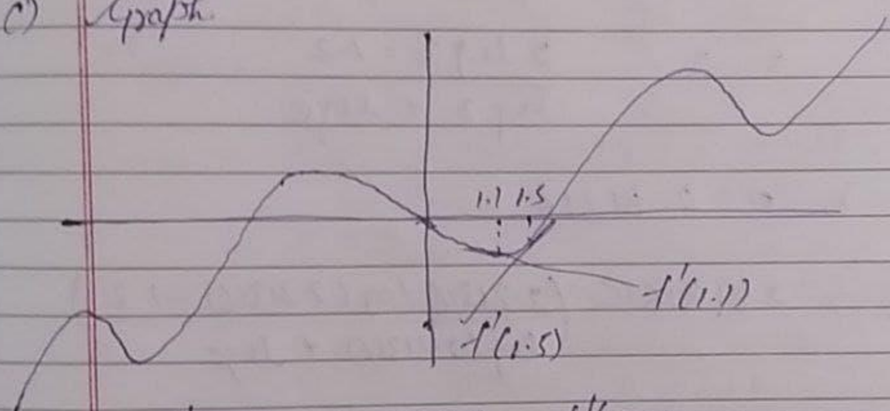
$x_4 = 1.89549$

$$x_5 = 1.89549 - \left(\frac{1.89549 - 2\sin(1.89549)}{1 - 2\cos(1.89549)}\right)$$

$= 1.8954992$

value is matching upto 5 decimal.

c) Graph



$f'(1.1) = 0.0928 \quad f'(1.5) = 0.8585$

As at 1.1 $f'(1.1)$ is tending to 0 making slope parallel to x-axis and that is why it intersect very far away.
In 1.5 $f'(1.5)$ is 0.8585 that cut x-axis ~~nearby~~ nearby
So the drawback is if the slope of f become zero at some point it will create the tangent line parallel to x-axis and it never intersect axis and we don't any root.

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P.2 $f(x) = x \log x - 1.2$

$f'(x) = \log x + \log e$

taking $x = 2$,

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

$$= 2 - \frac{2 \log 2 - 1.2}{\log 2 + \log e}$$

$x_1 = 2.81316.$

$$x_2 = 2.81316 - \left(\frac{2.81316 \log(2.81316) - 1.2}{\log(2.81316) + \log e}\right)$$

$= 2.74111$

$$x_3 = 2.74111 - \left(\frac{2.74111 \log(2.74111) - 1.2}{\log(2.74111) + \log e}\right)$$

$= 2.74065$

$$x_4 = 2.74065 - \left(\frac{2.74065 \log(2.74065) - 1.2}{\log(2.74065) + \log e}\right)$$

$= 2.7406531$

So, x_4 is similar upto 5 decimal
2.74065 is approx root

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Q3 $f(x) = \cos x - xe^x$

$f(0) = 1$

$f(1) = -2.177979$

$f(0.6) = -0.267936$

let $x_1 = 0$ $\quad f(0) = 1$

$x_0 = 0.6$ $\quad f(x_0) = -0.267936$

1st Approx.

$$x_1 = 0.6 - (0.267936)\left(\frac{0-0.6}{1-(-0.267936)}\right)$$

$= 0.47321$

$f(x_1) = \cos(0.4732) - (0.47321)e^{(0.47321)}$

$= 0.130542$

2nd ~~Approx~~ -

$$x_2 = 0.47321 - (0.130542)\left(\frac{0.6-0.47321}{-0.267-0.1306}\right)$$

$= 0.514747$

3rd Approx:

$f(x_2) = 0.009135$

$$x_3 = 0.514747 - 0.009135\left(\frac{0.47321-0.514747}{0.130542-0.009135}\right)$$

$= 0.517872$

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4^{th} Approx:

$$f(x_3) = -0.000349687$$

$$x_4 = 0.517872 - (-0.000349)\frac{(0.514747 - 0.517872)}{0.009135 - (-0.000349687)}$$

$$= 0.517757$$

$$f(x_4) = 8.8265 \times 10^{-7}$$

the Root of eq^n is 0.517757

Using Regula falsi method.

$$f(x) = \cos x - x e^x$$

$x_0 = 0$ $x_1 = 0.6$

$$f(x_0)\, f(x_1) < 0 .$$

first approximation

$$x_2 = 0 - \left(\frac{0.6 - 0}{0.2679 - 1}\right)$$

$$= 0.4732$$

$$f(x_2) = 0.130571$$

$$f(x_1)\, f(x_2) < 0$$

$$x_3 = 0.6 - (-0.267936)\left(\frac{0.6 - 0.4732}{-0.26793 - 0.130571}\right)$$

$$= 0.51472$$

$$f(x_3) = 0.0092165$$

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$f(x_1)\, f(x_3) < 0$

So we take $f(x_1)$ & $f(x_3)$

$x_3 = 0.51472 \quad f(x_3) = 0.0092165$

$$x_4 = 0.6 - \frac{(-0.267936)(0.6 - 0.51472)}{(-0.267936 - 0.009216)}$$

$= 0.5175837$

$f(x_4) = -0.003051$

$f(x_3)\, f(x_4) < 0$

$$x_5 = 0.51472 - \frac{(0.00931)(0.51472 - 0.5175)}{0.0092165 - (-0.003051)}$$

$= 0.51778$

$f(x_5) = 0.00052$

So, Approx root 0.517758

We can see Regulafalsi is a bit slow as after 5 approx we only get error approx of 10^{-4} while in secant method in 4 approx we got accuracy of 10^{-7}.

P4)

```
#include <iostream>
using namespace std;
double Function(double x)
{
    return (x*x*x - 2*x - 5) ;
}
double Function_derivative(double x)
{
    return (3*x*x -2) ;
}
void new_Raphson(double x, double r)
{
    int i = 0;
    double a;
    do
{
    a = x - (Function(x) / Function_derivative(x));
    x = a;
    i++;
}
while (((Function(a)>= r)||(Function(a)<= -r))&&(i<1000));
cout <<"The approximated root of equation is "<<a<< endl;
}
int main()
{
    double initial, range;
    cout << "Enter the initial guess " << endl;
    cin >> initial;
    cout << "Enter the permissible error " << endl;
    cin >> range;
    new_Raphson(initial , range);
    return 0;
}
```

Output

Enter the initial guess

2

Enter the permissible error

0.001

The approximated root of equation is 2.09457

Same code for 1st problem

Enter the initial guess

1.1

Enter the permissible error

0.001

The approximated root of equation is -1.895