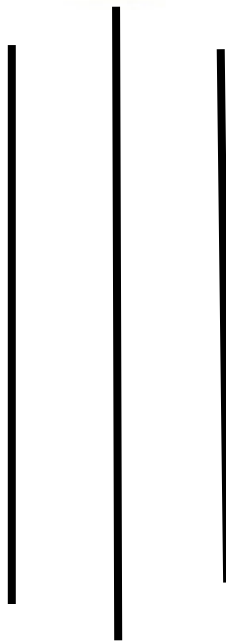


NEPAL ENGINEERING COLLEGE

(AFFILIATED TO POKHARA UNIVERSITY)

Changunarayan, Bhaktapur



REPORT ON:

Root of Nonlinear Equation Using Bisection Method

SUBMITTED BY:
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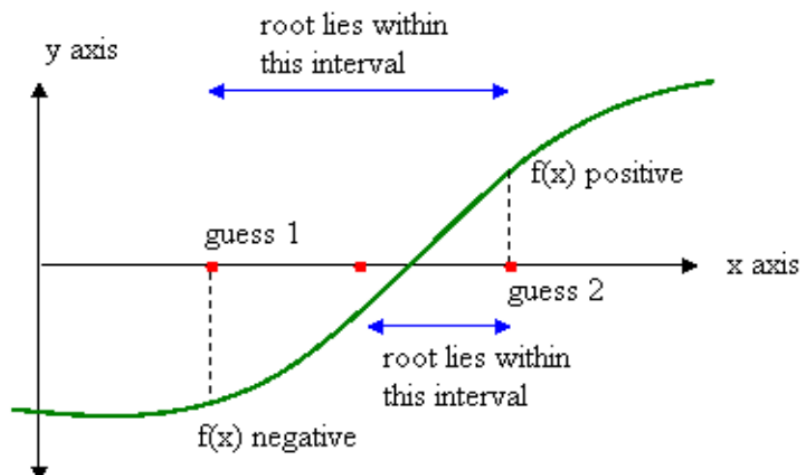
SUBMITTED TO:
Electrical and

Experiment No: - 2**TITLE:-****Root of Nonlinear Equation Using Bisection Method****OBJECTIVE:-**

To implement and calculate the root using the bisection method on Matlab and C-programming.

THEORY:-

The bisection method, which is alternatively called binary chopping or interval halving, is one type of incremental search method in which the interval is always divided in half. If a function changes sign over an interval, the function value at the midpoint is evaluated. The location of the root is then determined as lying at the midpoint of the subinterval within which the sign change occurs. The process is repeated to obtain refined estimates. An equation $f(x) = 0$, has at least one root between guess 1 (x_1) and guess 2 (x_2) if $f(x_1) * f(x_2) < 0$.



ALGORITHM:-

Step 1: Guesses the initial x_1 and x_2 which enclose the root i.e.

$$f(x_1) * f(x_2) < 0.$$

Step 2: Calculate error = $|x_2 - x_1| \geq 0.001$

Step 3: Calculate the $x_0 = \frac{x_1 + x_2}{2}$.

Step 4: Calculate $f(x_0)$.

Step 5: **if** $f(x_0) * f(x_1) < 0$ then // Condition check

Replace the value of x_2 by x_0 .

else

Replace the value of x_1 by x_0 .

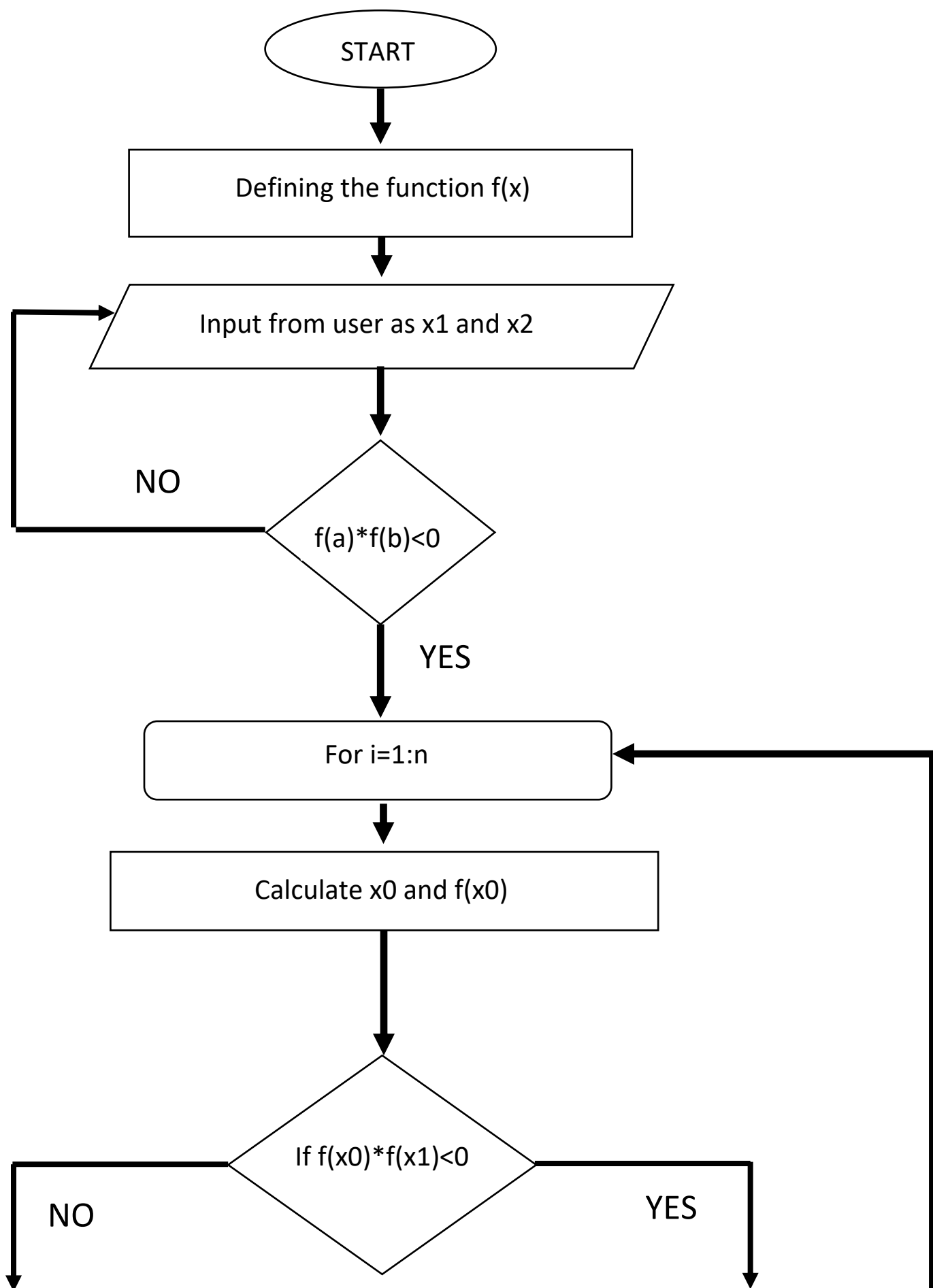
Step 6: **If** absolute value of (x_0) is less than or equal to give limit, then $root = x_0$ (Go to step 7)

else

Go to step 3.

Step 7: Stop the program

FLOW-CHART



$x_1 = x_0, x_2 = x_2$

$x_2 = x_0, x_1 = x_1$



Print the root

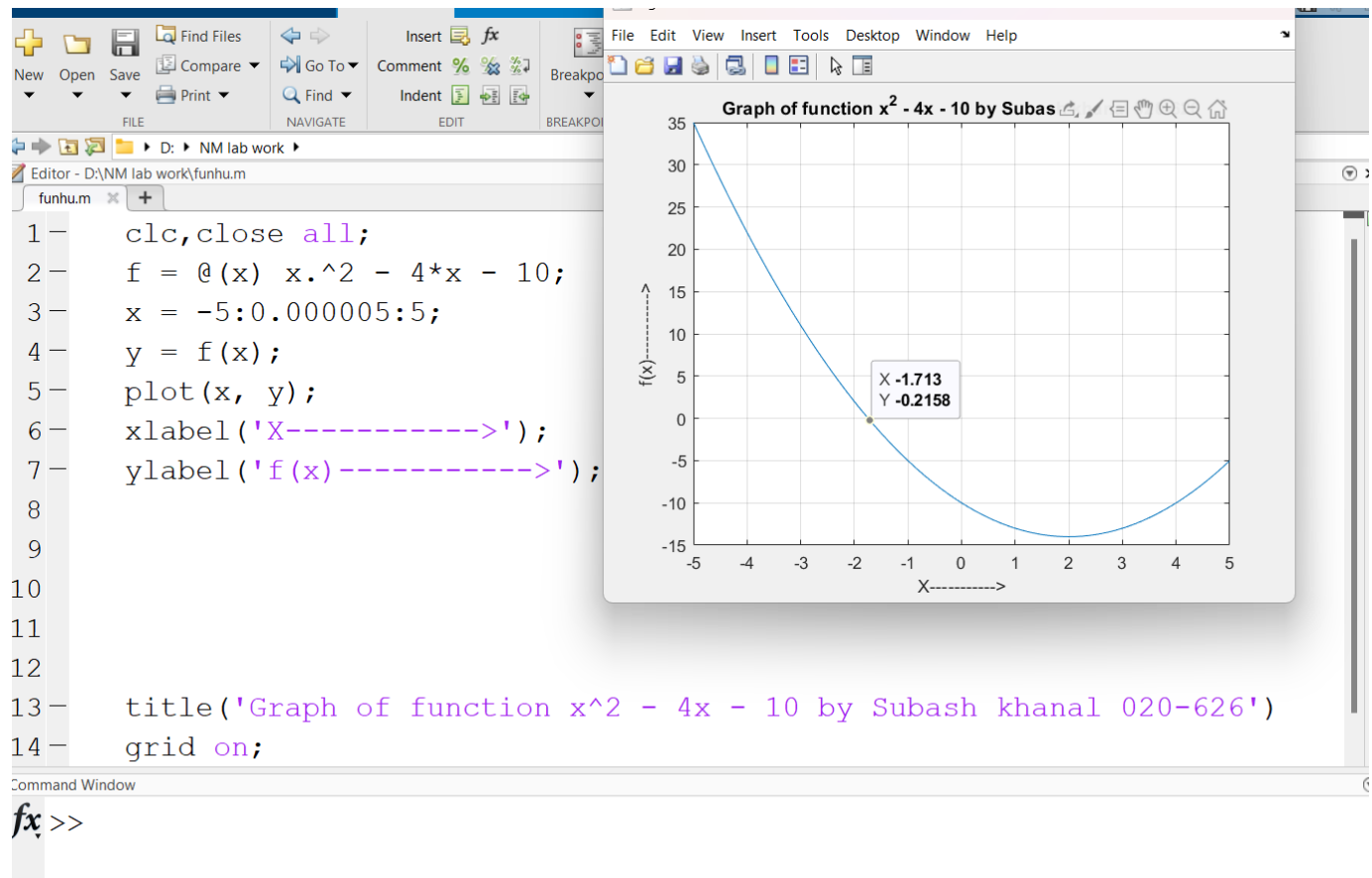
STOP

Question: Implement above algorithm in MATLAB to calculate a root of the following equations

a) $x^2 - 4x - 10 = 0$

Solution:-

Graph of the given Function:-



So from the above the root is nearly equal to **-1.713**.

Using C-programming

Syntax:-

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

double func(double x) {
    // Defining the function
    return x*x-4*x-10;
}

double bisection(double a, double b, double epsilon) {
    double c;
    int iterations = 0;

    printf("Iteration\t a\t\t b\t\t c\t\t f(c)\n");

    while (1) {
        c = (a + b) / 2.0;

        printf("%8d\t%10.6f\t%10.6f\t%10.6f\t%10.6f\n",
iterations, a, b, c, func(c));

        if (func(c) == 0.0 || fabs(b - a) < epsilon) {
            break;
        }
        if (func(c) * func(a) < 0) {
            b = c;
        } else {
            a = c;
        }
    }
}
```

```

    }

    iterations++;

    if (iterations > 100) {
        printf("Maximum iterations exceeded.\n");
        break;
    }
}

printf("\n\nSubash Khanal\n CRN:(020-626)\n\n");

return c;
}

int main() {
    double a, b, epsilon;
    double root;
    printf("Enter the value of a:");
    scanf("%lf",&a);
    printf("Enter the value of b:");
    scanf("%lf",&b);
    epsilon = 0.00001;

    // Call the bisection method
    root = bisection(a, b, epsilon);
    printf("Approximate root: %lf\n", root);

    return 0;
    getch();
}

```


Output:-

```
D:\NM lab work\bisectionmet × + v
Enter the value of b:-2
Iteration      a          b          c          f(c)
0             -1.000000   -2.000000   -1.500000   -1.750000
1             -1.500000   -2.000000   -1.750000    0.062500
2             -1.500000   -1.750000   -1.625000   -0.859375
3             -1.625000   -1.750000   -1.687500   -0.402344
4             -1.687500   -1.750000   -1.718750   -0.170898
5             -1.718750   -1.750000   -1.734375   -0.054443
6             -1.734375   -1.750000   -1.742188    0.003967
7             -1.734375   -1.742188   -1.738281   -0.025253
8             -1.738281   -1.742188   -1.740234   -0.010647
9             -1.740234   -1.742188   -1.741211   -0.003341
10            -1.741211   -1.742188   -1.741699    0.000313
11            -1.741211   -1.741699   -1.741455   -0.001514
12            -1.741455   -1.741699   -1.741577   -0.000600
13            -1.741577   -1.741699   -1.741638   -0.000144
14            -1.741638   -1.741699   -1.741669    0.000085
15            -1.741638   -1.741669   -1.741653   -0.000030
16            -1.741653   -1.741669   -1.741661    0.000028
17            -1.741653   -1.741661   -1.741657   -0.000001

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Approximate root: -1.741657

-----
Process exited after 9.048 seconds with return value 0
Press any key to continue . . . |
```

The root of the given function is highlighted in the output of c-programming output which was -1.7416257 which is nearly equal to -1.713 which was interception/root from Matlab graph.

Using Matlab.

Syntax:-

```
clc,close all;
f = @(x) x^2-4*x-10; %function
%Taking intial value from user .
a=input('Enter the first guess value,a:');
b=input('Enter the first guess value,b:');
n=30;
e=0.001;
disp('Prepared by Subash Khanal (020-
626) ')
fprintf('iter\t a\t\t b\t\t c\t\t
f(c)\t\t error\n')
%for printing in the table from
if f(a)*f(b)<0
    for i=1:n
        c=(a+b)/2;
        err=min(abs(c-a),abs(c-b));
        fprintf('%d\t %4f\t %4f\t %4f\t
%4f\t %4f\n',i,a,b,c,f(c),err)

        if(err<e)
            disp(['Root=' num2str(c)])
            break
        end
        if f(c)*f(a)<0 %first condition
            b=c;
        elseif f(c)*f(b)<0 %Second
condition
            a=c;
```

```

        end
    end
else
    % if the root is not define i betwwen
the guess
    disp('No root between given interval')
end

```

Output:-

The screenshot shows a MATLAB script in the Editor window and its execution output in the Command Window.

Script (funhum.m):

```

1 clc,close all;
2 f = @(x) x^2-4*x-10; %function
3 a=input('Enter the first guess v
4 b=input('Enter the first guess v
5 n=30;
6 e=0.001;
7 disp('Prepared by Subash Khanal
8 fprintf('iter\t a\t\t\t b\t\t\t
9 if f(a)*f(b)<0
10     for i=1:n
11         c=(a+b)/2;
12         err=min(abs(c-a),abs(c-b
13         fprintf('%d\t %4f\t %4f\t
14
15         if(err<e)
16             disp(['Root=' num2st
17             break
18     end

```

Command Window Output:

```

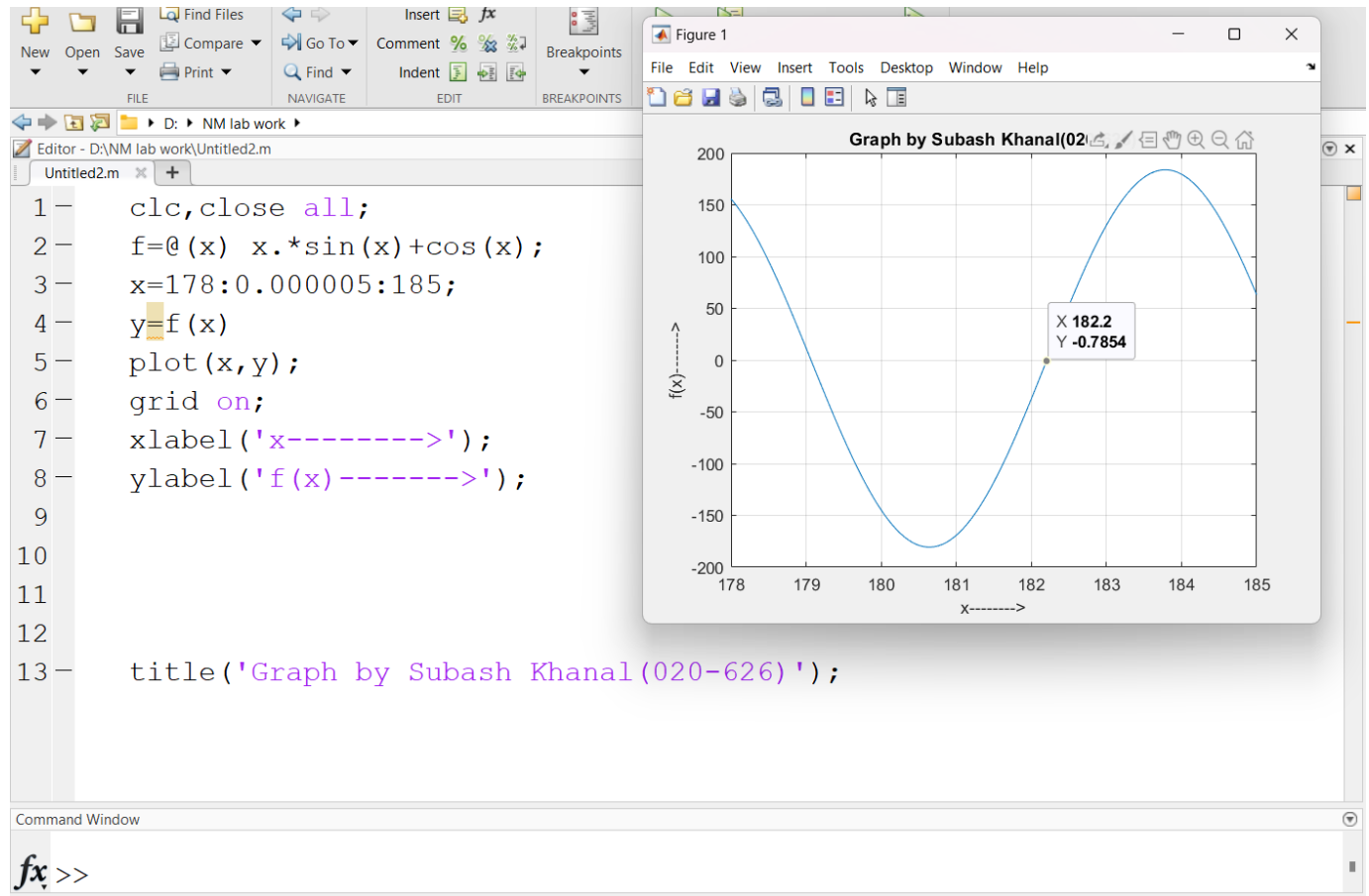
Enter the first guess value,a:-1
Enter the first guess value,b:-2
Prepared by Subash Khanal (020-626)
iter      a          b          c          f(c)          error
1      -1.000000      -2.000000      -1.500000      -1.750000      0.500000
2      -1.500000      -2.000000      -1.750000      0.062500      0.250000
3      -1.500000      -1.750000      -1.625000      -0.859375      0.125000
4      -1.625000      -1.750000      -1.687500      -0.402344      0.062500
5      -1.687500      -1.750000      -1.718750      -0.170898      0.031250
6      -1.718750      -1.750000      -1.734375      -0.054443      0.015625
7      -1.734375      -1.750000      -1.742188      0.003967      0.007813
8      -1.734375      -1.742188      -1.738281      -0.025253      0.003906
9      -1.738281      -1.742188      -1.740234      -0.010647      0.001953
10     -1.740234      -1.742188      -1.741211      -0.003341      0.000977
Root=-1.7412
fx>>

```

b) $x\sin(x) + \cos(x) = 0$

Solution:-

Graph of the given Function:-



So from the above the root is nearly equal to **182.2**.

Using C-programming

Syntax:-

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

double func(double x) {
    // Defining the function
    return x*sin(x)+cos(x);
}

double bisection(double a, double b, double epsilon) {
    double c;
    int iterations = 0;

    printf("Iteration\t a\t\t b\t\t c\t\t f(c)\n");

    while (1) {
        c = (a + b) / 2.0;

        printf("%8d\t%10.6f\t%10.6f\t%10.6f\t%10.6f\n",
iterations, a, b, c, func(c));

        if (func(c) == 0.0 || fabs(b - a) < epsilon) {
            break;
        }
        if (func(c) * func(a) < 0) {
            b = c;
        } else {
            a = c;
        }
    }
}
```

```
        iterations++;

        if (iterations > 100) {
            printf("Maximum iterations exceeded.\n");
            break;
        }
    }

    printf("\n\nSubash Khanal\n CRN:(020-626)\n\n");

    return c;
}

int main() {
    double a, b, epsilon;
    double root;
    printf("Enter the value of a:");
    scanf("%lf",&a);
    printf("Enter the value of b:");
    scanf("%lf",&b);
    epsilon = 0.00001;

    // Call the bisection method
    root = bisection(a, b, epsilon);
    printf("Approximate root: %lf\n", root);

    return 0;
    getch();
}
```

Output:-

```
D:\NM lab work\bisectionmet  X + v
Enter the value of a:175
Enter the value of b:185
Iteration      a          b          c          f(c)
0      175.000000    185.000000    180.000000   -144.805935
1      180.000000    185.000000    182.500000    52.729907
2      180.000000    182.500000    181.250000   -148.153248
3      181.250000    182.500000    181.875000   -59.258850
4      181.875000    182.500000    182.187500    -3.531557
5      182.187500    182.500000    182.343750    24.878140
6      182.187500    182.343750    182.265625    10.699840
7      182.187500    182.265625    182.226563     3.585351
8      182.187500    182.226563    182.207031     0.026520
9      182.187500    182.207031    182.197266    -1.752697
10     182.197266    182.207031    182.202148    -0.863123
11     182.202148    182.207031    182.204590    -0.418308
12     182.204590    182.207031    182.205811    -0.195896
13     182.205811    182.207031    182.206421    -0.084688
14     182.206421    182.207031    182.206726    -0.029084
15     182.206726    182.207031    182.206879    -0.001282
16     182.206879    182.207031    182.206955     0.012619
17     182.206879    182.206955    182.206917     0.005669
18     182.206879    182.206917    182.206898     0.002194
19     182.206879    182.206898    182.206888     0.000456
20     182.206879    182.206888    182.206883    -0.000413

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CRN:(020-626)

Approximate root: 182.206883

-----
Process exited after 14.5 seconds with return value 0
Press any key to continue . . . |
```

The root of the given function is highlighted in the output of c-programming output which was 182.206883 which is equal to 182.20 which was interception/root from Matlab graph.

Using Matlab

Syntax:-

```
clc,close all;
f = @(x) x.*sin(x)+cos(x); %function
%Taking intial value from user .
a=input('Enter the first guess value,a:');
b=input('Enter the first guess value,b:');
n=30;
e=0.001;
disp('Prepared by Subash Khanal (020-
626) ')
fprintf('iter\t a\t\t b\t\t c\t\t
f(c)\t\t error\n')
%for printing in the table from
if f(a)*f(b)<0
    for i=1:n
        c=(a+b)/2;
        err=min(abs(c-a),abs(c-b));
        fprintf('%d\t %4f\t %4f\t %4f\t
%4f\t %4f\n',i,a,b,c,f(c),err)

        if(err<e)
            disp(['Root=' num2str(c)])
            break
        end
    end
    if f(c)*f(a)<0 %first condition
```



```

        b=c;
    elseif f(c)*f(b)<0 %Second
condition
        a=c;
    end
end
else
    % if the root is not define i betwwen
the guess
    disp('No root between given interval')
end

```

Output: -

The screenshot shows the MATLAB environment with an Editor window on the left and a Command Window on the right.

Editor Window (funhum.m):

```

4  e first guess value,a:');
5  e first guess value,b:');
6
7
8  Subash Khanal (020-626)')
9  \t\t b\t\t c\t\t f(c
10 the table from
11
12
13 ;
14 bs(c-a),abs(c-b));
15 %d\t %4f\t %4f\t %4f\t %4f
16
17
18 ['Root=' num2str(c)]
19
20
21

```

Command Window:

```

Enter the first guess value,a:175
Enter the first guess value,b:185
Prepared by Subash Khanal (020-626)

```

| iter | a | b | c | f(c) | error |
|------|------------|------------|------------|-------------|----------|
| 1 | 175.000000 | 185.000000 | 180.000000 | -144.805935 | 5.000000 |
| 2 | 180.000000 | 185.000000 | 182.500000 | 52.729907 | 2.500000 |
| 3 | 180.000000 | 182.500000 | 181.250000 | -148.153248 | 1.250000 |
| 4 | 181.250000 | 182.500000 | 181.875000 | -59.258850 | 0.625000 |
| 5 | 181.875000 | 182.500000 | 182.187500 | -3.531557 | 0.312500 |
| 6 | 182.187500 | 182.500000 | 182.343750 | 24.878140 | 0.156250 |
| 7 | 182.187500 | 182.343750 | 182.265625 | 10.699840 | 0.078125 |
| 8 | 182.187500 | 182.265625 | 182.226563 | 3.585351 | 0.039063 |
| 9 | 182.187500 | 182.226563 | 182.207031 | 0.026520 | 0.019531 |
| 10 | 182.187500 | 182.207031 | 182.197266 | -1.752697 | 0.009766 |
| 11 | 182.197266 | 182.207031 | 182.202148 | -0.863123 | 0.004883 |
| 12 | 182.202148 | 182.207031 | 182.204590 | -0.418308 | 0.002441 |
| 13 | 182.204590 | 182.207031 | 182.205811 | -0.195896 | 0.001221 |
| 14 | 182.205811 | 182.207031 | 182.206421 | -0.084688 | 0.000610 |

fx Root=182.2064

Description:-

From above program on both c and matlab it was clear that root are same using any of c-programming or matalb and also from the graph. So, using above program we can find the root.

Conclusion:-

Hence, from above we can implement and calculate the root using the bisection method on Matlab and C-programming.