LAB NO: 01

LAB TITLE: BISECTION METHOD

OBJECTIVE: ⓐ To know about bisection method.
ⓑ Programatically solve the problem using bisection method.

THEORY:

① Root: Root can be defined as that value of a variable (say X) which satisfies its function.

ⓑ Bisection Method: Bisection method is a root finding method that applies to any continuous function with two values of opposite signs. It is a very simple method.

LAB WORK:

(i) $f(x)$ is continuous on $[a, b]$

(ii) $f(a) \cdot f(b) > 0$

Also, the algorithm is:

Step 1: Define $f(X)$

Step 2: Define error

Step 3: choose $a < b$ such that $f(a) * f(b) > 0$ such that root of equation lies between a and b

Step 4: use formula: $X = \frac{a+b}{2}$

Step 5: Compute $f(X)$

Step 6: → If $f(X) < E$, the value of X is root i.e root = X
of problem is solved
→ else
check if $f(a) * f(b) < b$
if true,
$b = X$
else
$a = X$
Go to step 4

Step 7: END

FLOWCHART

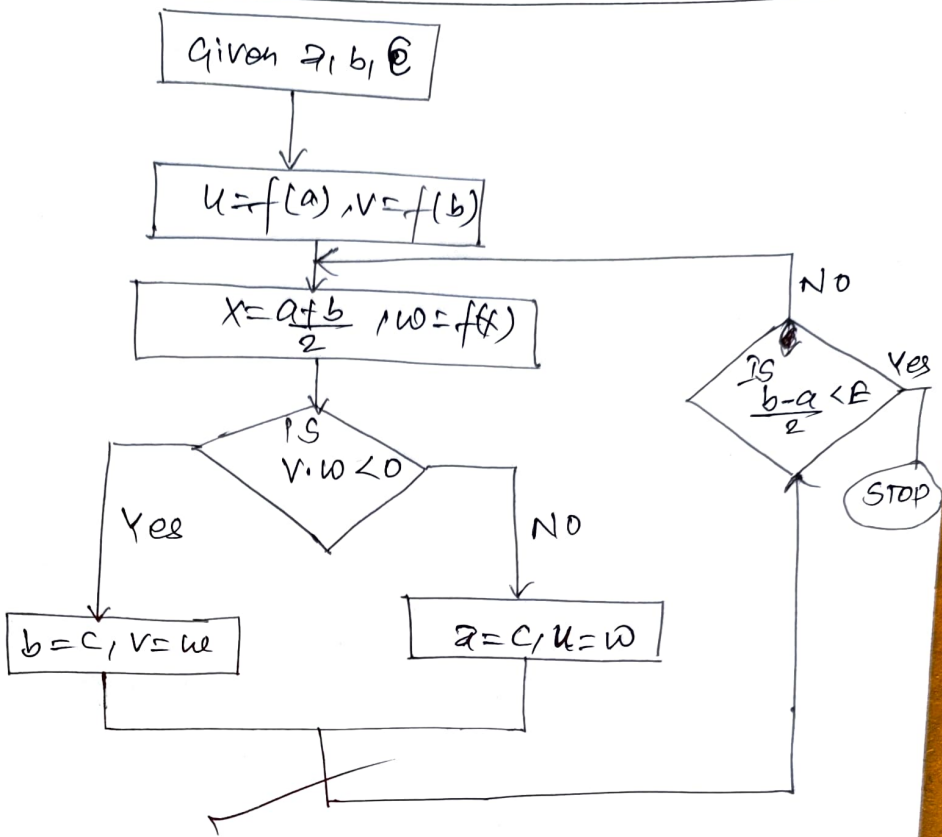

fig:- Flowchart of working of Bisection method.

(Q) Solve $xe^x = \sin x$ correct up to 4 decimal place.

Soln :- The program code to find the root is:

```
#include<stdio.h>
#include<math.h>
#include<conio.h>
#define E 0.00001  // since we are asked for 4 decimal place
//method that calculates functional value f(x)= xe^x - sinx
float f( float x)
{
   return x * exp(x) -sin(x);
}
int main()
{
 float a, b, x;
  int i=0;
  printf("enter the value of a and b\n");
  scanf("%d %d",&a ,&b);
```

```
if (f(a) * f(b) >= 0) {
    printf("Error!!");
    return 1;
}
do {
    x = (a+b)/2;
    printf("Iteration %d a=%f , b=%f, x=%f, f(x)=%f \n",
           i, a, b, x, f(x));
    if( f(x)==0 || (b-a)/2.0 < E){
        printf("Root is x=%f \n" x);
        break;
    }
    if( f(a) * f(b)) < 0)
    {
        b=x;
    } else a=x;
    i++;
} while (i<100);

}
```

OUTPUT: Enter the Initial value of a and b

-3

-2

Iteration 0 : a = -3.000000 , b = -2.000000 , X = -2.500000,
f(x) = 0.393260

Iteration 1: a = -3.000000, b = -2.500000 , X = -2.750000
f(x) = 0.205859

Iteration 76: a = -2.992203, b = -2.992186, X = -2.992195,
f(x) = -0.007297

∴ Root is X = -2.992195 //

DISCUSSION & CONCLUSION

In this lab experiment, we discussed about bisection method and learned how to solve it using programming language. We also made the algorithm to find the roots of the problem using bisection method. The above written 'C' code implements the bisection method to find the root of the given mathematical function $f(x) = xe^x - \sin(x)$. Here the user is asked to enter the value of a & b and the program checks if $f(a) \cdot f(b) < 0$ or not. If it gets to be true, error message is shown and program is terminated.

Here now our program proceeds to execute the bisection method, iteratively narrowing down the interval $[a, b]$, until a root is found or the maximum no. of iteration is reached. At each iteration, the values of a, b, x and f(x) are displayed in tabular format for better understanding.

Thus in Conclusion, Bisection method is a strong numerical technique for finding roots of functions within a given interval. It works on the principle of iteratively narrowing down the interval where the root is expected. In this lab work, we applied the bisection method to find the function $f(x) = xe^x - \sin x$ and after 17th iteration, we got the root as -2.9921 where initial value of a and b were -3 & -2.

Therefore, Bisection method is a valuable tool in numerical analysis for solving equation.