MA 322 (2021) Scientific Computing Lab Lab 01

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**Q1.**

Starting element chosen is: **x1 = 10**

Number of iterations such that **|xn+1 - xn| < 10-5** is: **5**

The order of convergence was initially assumed to be 1. Setting p = 1, the ratio was calculated. It could be seen that after several iterations, the sequence converges to a fixed constant c. Hence, the order of convergence is 1

**Q2.**

The roots obtained for various n are as follows:

For **n = 1**, the root obtained is = **3.0**

For **n = 5**, the root obtained is = **2.16**

For **n = 20**, the root obtained is = **2.02**

For **n = 100**, the root obtained is = **2.034**

For **n = 200**, the root obtained is = **2.027**

For **n = 400**, the root obtained is = **2.0305**

For **n = 1000**, the root obtained is = **2.0284**

For **n = 10000**, the root obtained is = **2.02882**

For **n = 50000**, the root obtained is = **2.0287640000000002**

With increasing n, the approximate root converged to the actual root value.

**Q3.**

Using  **= 0.1**, an approximate root was found using the Bisection method.

Approximate root of **f(x) = x/2 – sin x** in the interval [π/2, π]: **1.8653206380689396**

Then, the newton’s method was applied, using the approximate root as the initial value. This time,  **= 0.5 x 10-7**. The accurate root up to 7 decimal places is: **1.895494267033981**

**Q4.**

Similar to Q3,

Using  **= 0.1**, an approximate root was found using the Bisection method.

Approximate root of f(x) = x/2 – sin x in the interval [π/2, π]: **1.8653206380689396**

To apply Fixed Point Method, suitable g(x) was to be found.

**g(x) is continuous for all x in [π/2, π]**

**π /2 <= g(x) <= π for all x in [π/2, π]**

Hence, the fixed-point method can be applied.

Root obtained (with = 10-15): 1.895494267033981

It can be seen that g is a contraction with **L = 0.363**.

The ratio was calculated at each stage.

Theoretically, the above ratio should converge to the order of convergence.

Last three calculated ratios are as follows:

**0.99992 1.00017 0.99972**

The ratio converges to 1 after several iterations, and **hence order of convergence = 1.**

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**Q5.**

**x0 was set to -1, and x1 was set to 0**. Secant’s method was used to find the root. The results are as follows:

Method Used: Secant Method

Approximate root found: **-0.5791589060508369**

Number of iterations taken: 11

**Q6.**

Similar to Q3, using the bisection method with  **= 0.1**, approximate root was calculated.

Approximate root of f(x) in the interval **[-1,0]: -0.5625**

Using the approximate root as **x0**, the iterative procedure as per the question was applied.

Root obtained (with = 10-15): **1.895494267033981**

The ratio was calculated at each stage.

Theoretically, the above ratio should converge to the order of convergence.

Last three calculated ratios are as follows:

**1.00000 1.00000 0.99945**

The ratio converges to 1 after several iterations, and hence **order of convergence = 1.**

**Q7.**

Similar to Q6. **Order of convergence = 1**

**Q8.**

Similar to Q6. **Order of convergence = 2**

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**Order of Convergence:**

If p is the order of convergence, then

So, for large values of n,

Dividing both the equations, we obtain:

= p

Hence, as xn tends to , tends to the order of convergence. So, this ratio was calculated at each step. The ratio, after several iterations, converged to the required order of convergence.