

Computational Physics 1

Assignment 2:

Questions about Interpolation and Transcendental Equation

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1. Satellite datasets can play an important role in defining areas more accurately. Different satellite instruments can pose different problems, depending on spatial and temporal coverage, effects of clouds and rain cells, and viewing geometries. For determining the area of a specific place, satellite datasets is given with the following equation:

$$f(x) = \cos(x^2) - x + 3$$

To get the accurate geological model of that specific area different types of interpolation can be used which can help to get the mapping more clearly.

- a) Give a brief description of Lagrange Interpolation
- b) Write the algorithm of Lagrange Interpolation
- c) Show that the equation $f(x) = 0$ has a root in the interval $[2.5, 3]$
- d) Use the Linear Interpolation once on the interval $[2.5, 3]$ to find an approximation for giving your answer to 2 decimal places

2. Suppose, you are playing “MotoGP” with your brother on your PC. You are a professional like a gamer than your brother. But your brother has won the game. Because your brother is a physics undergraduate and he made a function from the track and calculated the best angle and speed for optimized result. The crucial part of the MotoGP speed track follows the equation:

$$f(x) = x^3 + 4x^2 - 10$$

He calculated the root of that function quickly and selected the place where his bike's speed will be so slow as to not to get out of the track.

- a) Show the difference between Bisection Method and False Position method
- b) Write the algorithm of Bisection Method
- c) Describe Bisection method and its iteration process.
- d) Show that the above mentioned equation has a root in $[1, 2]$ and use the Bisection method to determine an approximation to the root that is accurate to at least within 10^{-4}

3. Structural analysis in engineering is crucial for proper design and correct behavior of structures. Correct evaluation of the behavior and set the appropriate parameters avoid, almost always, future damage and even reduce the impact of disasters. Suppose your research instructor assigned your team to dynamically analyze a specific plane frame and report it's rigidity and stability as well. Your team members have calculated the characteristics equation of that specific plane which is given below:

$$f(x) = \frac{1}{x} - a \quad \text{where } a \text{ is a constant, is given by } x_{n+1} = x_n (2 - ax_n)$$

Now, the work of root finding and curve fitting is upon you.

- a) Give one advantage and one disadvantage of the Newton-Raphson method over the Secant method.
- b) Write down the algorithm of Newton-Raphson method
- c) Describe the Newton-Raphson iteration formula for n nonlinear equations in n variables
- d) Find the root of the above mentioned function using Newton-Raphson method. Estimate how many iterations would be needed to determine the root to 6 decimal places?