Lab Assignment 8

Wednesday, May 5, 2021

The electric field due to a point charge can be expressed as the negative gradient of the electric potential. Mathematically, it can be written as

$$\vec{E} = -\vec{\nabla}\phi \tag{1}$$

where,
$\vec{E}$ is the electric field,
ϕ electric potential due to the point charge, and
$\vec{\nabla}$ is the gradient operator ($\vec{\nabla} = \hat{\imath}\frac{d}{dx}$ in one dimentional case).

The potential due to a point charge is given by

$$\phi(x) = \frac{1}{4\pi\epsilon_0}\frac{q}{x} \tag{2}$$

where,
$\vec{\epsilon_0}$ is the permitivity of free space,
q is the point charge, and
x is the distance from the charge.

Question:

Develop a code to perform numerical differentiation using forward, backward and centered difference methods. Your code should have the following components.

- Firstly, generate the values of $\phi(x)$ in the range $1 \leq x \leq 5$ and store them in an array. Use a step-size of $h = 0.1$.

  You may take, for the ease of calculations, $\epsilon_0 = 1$, and $q = 1$ in their appropriate units.

- Write **three** user defined functions that differentiates the eq.(1) using forward, backward and centered calculations.

  The functions should be of the form

  ```
  double difference_method( double y1, double y2, double step );
  ```

- Use these functions in `main()`, and store the results in a file, along with the analytical result.

- Make a graph of the data obtained through forward, backward and centered calculations (with lines) along with the analytical data (with points).

- What do you infer from this exercise?

Note: Please send all the files attached to a folder and upload it. The uploaded folder (**folder-name format: Rollno.-name**) should contain the source code, the output file (graph in jpg/jpeg/png format) and the also observations in a seperate file. Please upload only the necessary files and refrain from uploading multiple files.