International Islamic University Chittagong (IIUC)

Department of Computer Science Engineering (CSE)

LAB PROJECT PROPOSAL

Course title : **Numerical Method Lab**

Course code : **CSE-4746**

Session : **Spring-2024**

Topic : **ODE Visualization Using MATLAB**

Submitted To:

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Introduction :

Ordinary Differential Equations (ODEs) are pivotal in modeling various engineering systems and processes, encompassing fields such as mechanics, electrical circuits, and chemical reactions. This project, titled "ODE Visualization Using MATLAB" aims to develop a MATLAB-based tool for numerically solving and visualizing the behavior of solutions to ODEs. By implementing multiple numerical methods and providing graphical representations of the results, this tool will assist engineers and researchers in understanding and analyzing ODEs more effectively.

Objectives :

1. **Develop a User-Friendly Interface**: Create an interface that allows users to input differential equations, initial conditions, and other relevant parameters with ease.
2. **Implement Multiple Numerical Methods**: Incorporate various numerical methods for solving ODEs, including Euler's Method, Heun's Method, the Midpoint Method, and the Runge-Kutta Method.
3. **Visualize Solutions**: Provide graphical plots to visualize the solutions generated by different numerical methods.
4. **Compare Methods**: Enable the comparison of different numerical methods in terms of accuracy and efficiency.
5. **Educational Utility**: Serve as an educational tool to demonstrate the application of numerical methods in solving ODEs.

Project Scope :

The project focuses on the following key areas:

- **Functionality**: Implement core functionalities to solve and visualize ODEs using MATLAB.
- **Method Support**: Support multiple numerical methods for solving ODEs.
- **Visualization**: Provide clear and informative plots of the solutions.
- **User Control**: Allow users to adjust parameters such as initial values, step sizes, and the point of evaluation.
- **Comparison and Analysis**: Offer features to compare the performance and accuracy of different methods.

Methodology :

1. **Input Handling**:
    - Prompt users to enter the ODE function, initial conditions, step size, and endpoint using MATLAB's input functions.

2. **Numerical Methods Implementation**:
    - Implement the following methods in MATLAB:
        - **Euler's Method**: A straightforward numerical approach using a simple iterative process.
        - **Heun's Method**: An improved version of Euler's method with better accuracy.
        - **Midpoint Method**: Uses the midpoint to achieve a more accurate result than Euler's method.
        - **Runge-Kutta Method (RK4)**: A higher-order method providing excellent accuracy by averaging several intermediate steps.

3. **Visualization**:
    - Use MATLAB's plotting functions to create graphs that depict the solutions obtained from each method.
    - Ensure each method's results are plotted with distinct markers and colors for clear differentiation.

4. **Comparison**:
    - Plot all methods on the same graph to allow visual comparison of the different solution trajectories.

5. **Documentation**:
    - Provide detailed comments in the code to explain each step and method.
    - Include usage instructions and theoretical background in the project documentation.

Expected Outcomes :

- **Functional MATLAB Tool**: A MATLAB script capable of solving ODEs using multiple numerical methods and visualizing the results.
- **Visualization of Solutions**: Graphical plots that illustrate how different numerical methods approximate the solution to the given ODE.
- **Method Comparison**: Comparative analysis of the methods in terms of accuracy and computational efficiency.
- **Educational Insights**: Enhanced understanding of numerical methods and their applications in solving ODEs.

Conclusion

The "ODE Visualization Using MATLAB" project aims to provide a comprehensive tool for solving and visualizing ordinary differential equations using various numerical methods. By implementing and comparing methods like Euler's, Heun's, Midpoint, and Runge-Kutta, the project not only aids in solving ODEs but also serves as an educational resource for understanding the nuances of these numerical techniques. This tool will be valuable for both engineers and researchers, enabling them to model, solve, and analyze ODEs effectively.