MIDDLE EAST TECHNICAL UNIVERSITY
DEPARTMENT OF MECHANICAL ENGINEERING
ME 310 NUMERICAL METHODS
FALL 2021
PROGRAMMING PROJECT 4

Assignment date : 18.01.2022
Due date : 26.01.2022
Prepared by :

The programming project will be submitted through METU-Class, as described in the "Programming Project Assignment Guidelines", which is posted on METU-Class.

Write a computer program to solve a system of first order ordinary differential equations (ODEs) using Heun's method with multiple application of the corrector step and using the fourth order Runge Kutta (RK4) method and compare the results obtained by both methods.

Your code should do the following:

- User defines a vector function named as ***f.ext*** which contains the ODEs in the proper format. (***ext*** is the extension referring to the programing language or software used)
- User defines an input file named as *input.txt* which contains the following (See the sample input file given at the end)
    - Number of equations.
    - Number of application of corrector step for Heun's method
    - Initial (x_i) and final values (x_f) for independent variable.
    - Initial values $(y_1^0 \quad y_2^0 \quad \cdots \quad y_n^0)$ for n dependent variables.
    - Step size (dx).
- Program should output results of the calculated functions as a table presented in the sample output (given at the end) both on screen and to an output file named as *output1.txt* for Heun's method and *output2.txt* for RK4 method.
- If you are using a software such as Matlab, Mathcad, Maple, Mathematica etc. your program should plot each calculated function in separate windows between the specified $[x_i, x_f]$ interval. This step is not required if you are using programing languages such as C/C++, Fortan, Pascal, Delphi etc.; however, you should include these plots in your report.

Present your results in a short report (a few pages of a word document only, saved as a pdf document), which should include the following:

- A basic introduction paragraph
- Necessary hand calculations to write your code (type it in the word document)
- Formulations used in the calculations
- Your numerical results
- Your plotted graphics
- Discussion of the results and conclusion
- Appendix section including your code

Sample input for a set of 3 first order ODEs is given below

```
3           ! Number of Equations
2           ! Number of Corrector Steps for Heun's method
1.00        ! Initial value of Independent Variable
3.00        ! Final Value of Independent Variable
0.25        ! Step Size
2.50  1.80  -2.30       ! Initial Conditions for Variables
```

Your output should look something like this:

x	y1	y2	y3
x_i	4.00000	6.00000	2.52345
x_i+dx	5.00000	6.00000	2.52345
x_i+2dx	6.00000	6.00000	5.52345
x_i+3dx	7.00000	6.00000	2.52345
.....	.....	.....	.....
x_f	40.00000	6.00000	2.52345