MATH–305 **PROGRAM ASSIGNMENT 3** **Fal 2021**

Due Friday, December 10 at 1:20

- **Review the document entitled, Programming Projects.**
- **Read the document posted on the course web site:**
  https://paws.kettering.edu/∼ktebeest/math305/proj-header3.pdf
- **You should not attempt this until you have the codes for the Euler method and the modified Euler method working and giving correct results. Also see the Maple examples and assignments on the course web site.**
- **Never retype results. Instead, store all results under descriptive names and use their names. Also, never retype quantities that have already been entered but have not been changed.**
- **All numeric results should be expressed in decimal form.**

Here you will write a program that uses the **classical Runge–Kutta** method to solve an initial value problem

$$\frac{dy}{dx} = f(x,y)\,, \qquad y(x_0) = y_0\,. \tag{1}$$

The function $f(x,y)$ should be written as a Maple **function**, **NOT** as a Maple expression. (See my examples or see the Maple Help Sheets.) The following quantities should be entered at the top of the code:

- function $f(x,y)$ for the DE,
- the interval endpoints a and b on which to solve the problem (a is x_0),
- the initial value y_0, and
- the number of steps N.

Use formatted printing. See the examples on the course web site. At each node the program should print the following in column-aligned **TABLE FORM**:

- the node number $(1, 2, 3, \ldots)$ as an integer,
- the node in decimal form x to 4 decimal places, and
- the approximate solution y at that node in decimal form to 6 decimal places).

Remember that in tables, decimal points should be aligned in each column.

Set the arithmetic precision to 20 at the top of your Maple code.

Here you will approximate the solution of the IVP

$$\frac{dy}{dx} \;=\; \left(x^2+y\right)^{1/2} e^{-x/y}\,, \qquad y(2)=3\,, \tag{2}$$

on the interval $[2,7]$.

1. Use your **classical Runge–Kutta** code to solve for y versus x on the interval $2 \le x \le 7$ using:
   (a) $N = 5$ steps, and
   (b) $N = 10$ steps.
2. For the $N = 10$ case,
   (a) plot the results for y versus x using the point style with symbols of size 24, and
   (b) plot the results for y versus x using the line style with a curve thickness of 6 and color blue.

   In both plots, restrict the vertical range to $0 \le y \le 20$.
3. At common nodes, how much more accurate do we expect the results in Step 1b to be than those from Step 1a? **Answer in a complete and coherent sentence.**
