Group of 3 students (not for distance students)

One of the world's most extensively studied ordinary differential equations is the Lorenz chaotic attractor. It was first described in 1963 by Edward Lorenz, an MIT mathematician and meteorologist, who was interested in fluid flow models of the earth's atmosphere. We have chosen to express the Lorenz equations in a somewhat unusual way, involving a matrix-vector product.

$$\dot{y} = Ay$$

The vector y has three components that are functions of t,

$$y(t) = [y_1(t),\, y_2(t),\, y_3(t)]^T$$

Despite the way we have written it, this is not a linear system of ordinary differential equations. Seven of the nine elements in the 3-by-3 matrix A are constant, but the other two depend on $y_2(t)$.

$$A = \begin{pmatrix} -\beta & 0 & y_2 \\ 0 & -\sigma & \sigma \\ -y_2 & \rho & -1 \end{pmatrix}$$

You are asked to:

- Create 3 functions implementing the following methods: Euler, Heun, Runge Kutta 4.
- Solve the previous system of ODE using those methods and plot the results.
- Plot the solution for the 3 methods.
- Write a 2 page report describing methods and results.
- Upload results to the Group Folder of the virtual center. e.g.
  HW2-LastName1-LastName2-LastName3.zip

Useful data

The most popular values of the parameters are $\sigma = 10$, $\rho = 28$, and $\beta = 8/3$.
Initial point: $y_0 = [\rho - 1, \eta, \eta - 3]^T$, where $\eta = \sqrt{\beta(\rho - 1)}$.
Time span: t from 0 to 10.
Discretizations: use at least 20 000 points for Euler, 10 000 for Heun and 5000 for RK4