Phys234, 2018, Problem set #8: In-lab questions

Question 1:

The following ODE with initial condition:

$$\frac{dy}{dt} = 2\cos(t) - \sin(t)\,, \qquad y(0) = 2$$

has the following analytical solution

$$y(t) = 2\sin(t) + \cos(t) + 1$$

Write a function `ps8q1` that computes numerical solutions of y between $t = 0$ and $t = 10$ using Euler's method with the function `odeEuler` that we saw in class. Obtain a solution for 3 different time-steps: $h = 0.1, 0.05, 0.01$ and produce a plot that shows a comparison between the analytical (true) solution and your numerical solution for each 3 values of h. Don't forget to include axis labels and a legend on your plot. You will have to create a file `rhsq1` that contains the right-hand side of the ODE.

Question 2:

The following ODE:

$$\frac{dy}{dt} = 2y - \frac{y^2}{10}\,, \qquad y(0) = 1$$

has the following analytical solution

$$y(t) = \frac{20}{1 + 19\exp(-2t)}$$

Write a function `ps8q2` that computes numerical solutions of y between $t = 0$ and $t = 5$ using 1) Euler's method (`odeEuler`), 2) the Midpoint method (`odeMidpt`), 3) 4th order Runge-Kutta (`odeRK4`) and the following 4 values of the timestep h: $h = 0.2, 0.1, 0.05, 0.025$. Compute for each method and each h the global discretization error. You can use the function `mycompEMRK4.m` (available on eclass) as a starting point, and adapt it to the present problem. You will have to create a file `rhsq2` that contains the right-hand side of the ODE.