Nonlinear Dynamics Lab

Session 8

due March 1, 2016

1. Consider the equation for the mathematical pendulum

$$\dot{q} = p$$
$$\dot{p} = -\sin q \,.$$

   Write a program that solves the mathematical pendulum with

   (a) the explicit Euler method,
   (b) the implicit Euler method,
   (c) the trapezoidal rule for differential equations.

   Take initial values $q(0) = 0$ and $p(0) = 1.9$ and plot example solutions $q(t)$ vs. t for each method into one graph for a time horizon of many oscillation periods.

2. Read up on the build-in ODE solvers in `scipy.integrate.ode`. Obtain a reference solution for the mathematical pendulum using one of these integrators for a fixed final time, e.g. $T = 10$, and determine the order of the previously implemented methods by plotting the error (the difference of the result of your solver vs. that of the built-in reference solver) vs. the step size on a doubly logarithmic scale.

   You should submit the runable code for each problem as well as a very short written description of your observations.