CTA 200: Homework 3

Problem 1a: Using odeint, write a script to solve

$$\frac{d^2x(t)}{dt^2} + x(t) = 0 \ . \tag{0.1}$$

The script should take input from the user for the total amount of time and the step size. Output the runtime for the calculation on the screen and make plot of the solution.

Problem 1b: Compute the difference between the numerical solution and the exact solution. Determine the average error over each period and plot the output (i.e. the data points should be the average error during the nth period shown as a function of n).

Problem 1c: Solve the same equation using ode (instead of odeint). Compute the runtime and the average error for one period using 5 different methods listed in the documentation for scipy.integrate.ode. Output the list of methods, including odeint, ranked from fastest to slowest and most accurate to least accurate.

Problem 2: Write a script that numerically solves for the time evolution of a charged particle in a magnetic field (in 3 dimensions)

$$m\frac{d^2\vec{x}(t)}{dt^2} = q\vec{v} \times \vec{B} \ . \tag{0.2}$$

(you can define your units such $m = q = 1$ to make life easy). The script should compute a solution given any function that computes $\vec{B}$ (i.e. the specific form of B should not be used when solving for the motion of the particle). Solve for the evolution in a uniform magnetic field in the z-direction, given an initial (non-zero) velocity in the y-direction. Plot the solution in the x-y plane.

Send solutions to cta200@cita.utoronto.ca by Monday, May 11 at 5 pm