PY2105 Introduction to Computational Physics

Autumn 2019

Dr. A. Kiely

Problem Set 4

Based on the results of the lectures, implement the numerical solution of the differential equation of the driven, damped, non-linear oscillator

$$\frac{d^2\theta}{dt^2}(t) = -\Omega^2 \sin(\theta(t)) - 2\gamma\frac{d\theta}{dt} + f_0 \cos(\Omega_D t)$$

using the Euler-Cromer method. The approximation of $\theta(t)$ for $0 \leq t \leq T$ (notation as in the lecture) should be plotted as a JPG file at the end.
Use this program for the following tasks:

1. Let $f_0 = 0$, $T = 10$, $\Omega = 1$, $\theta(0) = 1$, $\omega(0) = 0$. Calculate numerically the approximations of $\theta(t)$ for the values $\gamma = 0$, $\gamma = 0.5$, $\gamma = 1.0$, $\gamma = 1.5$. Choose a time step Δt which is small enough such that the results do not differ significantly when the time step is reduced by a factor of 2. Produce four different JPG files for the four different γ values.

2. Let $f_0 = 0.5$, $T = 50$, $\Omega = 1$, $\Omega_D = 2/3$, $\theta(0) = 0.2$, $\omega(0) = 0$. Calculate the numerical approximation $\theta(t)$ for the values $\gamma = 0.25$ and $\gamma = 1.0$. Choose a time step Δt which is small enough such that the results do not differ significantly when the time step is reduced by a factor of 2. Produce two different JPG files for the two different γ values.

Submit the source code of the programme as well as the different JPG files to "Canvas" using the following name convention:
Surname_Firstname_PS4.cxx

Surname_Firstname_PS4_a_0.0.jpg, Surname_Firstname_PS4_a_0.5.jpg,
Surname_Firstname_PS4_a_1.0.jpg, Surname_Firstname_PS4_a_1.5.jpg

Surname_Firstname_PS4_b_0.25.jpg, Surname_Firstname_PS4_b_1.0.jpg

The deadline is

Tuesday, 22nd October, 18:00