Project for Computational Physics Course 2010

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Project Proposal

Harmonic Oscillator With Viscous Friction.
The 2^{nd} order differential equation is that of a harmonic oscillator,

$$\frac{d^2x}{dt^2} + 2\beta(\frac{dx}{dt})^2 + \omega^2 x = 0 \tag{1}$$

It has a simple analytic solution.But it is not immediately solvable by using Runge-Kutta or Euler method.
To make this problem for numerical methods I can start with

$$y^{(1)}(t) \equiv x(t) \tag{2}$$

$$\frac{dy^{(1)}}{dt} \equiv y^{(2)} \tag{3}$$

$$\Rightarrow \frac{dy^{(2)}}{dt} = \frac{d^2y}{dt^2} = \frac{d^2x}{dt^2} \tag{4}$$

Then i can get,

$$\frac{dy^{(1)}}{dt} = y^{(2)} \tag{5}$$

$$\frac{dy^{(2)}}{dt} = -2\beta\frac{dy^{(1)}}{dt} - \omega^2 x(t) \tag{6}$$

So We thus solve a single 2^{nd} order differential equation by solving simultaneously two first order equations.
So,using
The forth-order Runge-Kutta algorithm to solve the equation of the harmonic oscillator with friction,

$$\frac{d^2y}{dt^2} + 2\beta(\frac{dy}{dt})^2 + \omega^2 y = 0 \tag{7}$$

- Cases that I will consider for
- $\beta = 0$

- $\beta^2 < \omega^2$
- $\beta^2 > \omega^2$
- $\beta^2 = \omega^2$
- Then I will determine the energy and the energy loss of the system with time. Then I will tally with my analytical solution.If not then I have to change the step size of my algorithm or even use a different method to solve my problem.
- Then try to compare which algorithm will give the better accuracy by plotting data in gnuplot.
- If a periodic force is applied with this harmonic oscillator then how the solution will change.