In the name of God

Department of Physics
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ADVANCED COURSE ON COMPUTATIONAL PHYSICS

Exercise Set 9

(Due Date: 1403/09/25)

1. For the following equation,

$$y''(t) + ay'(t) + \omega^2 y(t) = \cos(\omega_1 t)$$

with $y(0) = A$, $y'(0) = 0$ and take any arbitrary values for other free parameters, use finite difference method to solve y as a function of t. Suppose the $t_{initial} = 0$ and $t_{final} = 10$ with $N = 1000$.

2. Solve Laplace's equation ($\nabla^2\Phi(x, y) = 0$) numerically for a 2D area with 300×300 pixels. Suppose that $\Phi(0, y) = y^2$, $\Phi(x, 0) = x$, $\Phi(L, y) = 0$ and $\Phi(x, L) = 1$ (relaxation method or finite difference method)

3. Logistic map: plot bifurcation, one-cycle, two-cycle, four-cycle and chaotic regime.

4. Chaotic oscillation: suppose the following equation:

$$\frac{d^2\theta}{dt^2} = -\omega_0^2 \sin\theta - \alpha\frac{d\theta}{dt} + f\cos(\omega)$$

where $\omega_0 = 1$, $\alpha = 0.2$, $f = 0.52$ and $\omega = 0.666$. Plot phase diagram and $\left|\frac{d\theta}{dt}\right|$ as a function of driving force f. (You can use the Mathematica to solve it)

5. Lorenz attractor: suppose following coupled equations:

$$\frac{dx}{dt} = 10(y - x)$$

$$\frac{dy}{dt} = -xz + 28x - y$$

$$\frac{dz}{dt} = xy - \frac{8}{3}z$$

Solve them and plot phase diagram of each of them. (You can use the Mathematica to solve them)

Good luck, Movahed