In the name of God

Department of Physics
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ADVANCED COURSE ON COMPUTATIONAL PHYSICS AND OPTIMIZATION

Exercise Set 5

(Due Date: 1403/02/15)

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

2. 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.

3. 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.

4. Lyapunov Exponent: There are many methods to compute Lyapunov exponent such as delay method presented in Physica D 65 (1993) 117-134.
A: However according to those method presented in the class, compute the Lyapunov exponent for the Logistic map as a function of μ.
B: Determine the Lyapunov exponent for the chaotic systems given in Q.2 and Q.3.

5. Lyapunov Exponent for a time series: compute the Lyapunov exponent for the given time series.

Good luck, Movahed