AME 630: Transition to Chaos in Dynamical Systems
Prof. P.K. Newton, RRB 221, 740-7782 (newton@usc.edu)
Spring 2016
Time: MW 2:00-3:20 VHE 206

The course will focus on the main ideas and techniques in dynamical systems and chaos theory developed over the past 30 years by introducing examples that have served as useful prototypes. There are 4 parts to the course:

1. Review of basic dynamics
2. Iterated maps
3. Bifurcation theory
4. Hamiltonian systems

Part 1 will briefly survey some of the main ideas of basic dynamics including phase space techniques, fixed points, stability theory, Lyapunov functions. Part 2 focuses on the dynamics of iterated maps, the simplest setting in which chaotic behavior can occur. This will lead to a discussion of bifurcation phenomena, Feigenbaum scaling theory and Lyapunov exponents in prototype maps such as the logistic map, the 'standard' map, and the Hénon map. Part 3 will outline basic techniques of bifurcation theory related to differentiable dynamics, including discussions of center manifolds, unfolding a bifurcation, and the Hopf bifurcation. Part 4 will focus on the dynamics of Hamiltonian systems, including the forced, damped pendulum. Physical examples will be highlighted throughout the semester, including examples from population biology, dripping faucets, thermal convection, vortex dynamics of the atmosphere, nonlinear spring-mass systems, gases of hard spheres and stock market time series. Each student will work on a project and give a seminar at the end of the semester.

Books:
• K.T. Alligood, T.D. Sauer, J.A. Yorke, *Chaos: An Introduction to Dynamical Systems*, Springer-Verlag, (Paperback)