Course title: Introduction to Dynamical Systems and Chaos
Course Number: JFL 215
Subject/ discipline: Applied Mathematics, Physics
L-T-P: 3-1-0
Total credits: 4
Course type & evaluation: lectures, assignments, mid & end-term examinations & project

Instructor: Janaki Balakrishnan

Brief description:
The course introduces basic mathematical techniques to understand qualitatively the long-term behaviour of systems evolving in time. Most of the phenomena occurring in nature, and around us, are nonlinear and often these exhibit interesting behaviour which could be unpredictable and counter-intuitive. Tools and techniques of dynamical systems theory help in understanding the behaviour of systems and in gaining control over their behaviour, to a certain extent. Dynamical systems theory has wide applications in the study of complex systems, including physical & biological systems, engineering, aerodynamics, economics, etc.

Course content:
linear stability analysis, attractors, limit cycles, Poincare-Bendixson theorem, relaxation oscillations, elements of bifurcation theory: saddle-node, transcritical, pitchfork, Hopf bifurcations, integrability, Hamiltonian systems, Lotka-Volterra equations, Lyapunov function & direct method for stability, dissipative systems, Lorenz system, chaos & its measures, Lyapunov exponents, strange attractors, perturbation methods, simple maps, period-doubling bifurcations, Feigenbaum constants, fractals.
Both flows (continuous time systems) & discrete time systems (simple maps) will be discussed. Assignments will include numerical simulations.

Prerequisites, if any: familiarity with linear algebra - matrices, and ordinary differential equations

Desirable: ability to write codes for solving simple problems.

Suggested Books:
1. S. Strogatz, Nonlinear Dynamics and Chaos: with Applications to Physics, Biology, Chemistry, and Engineering, Westview, 1994
2. S. Wiggins, Introduction to applied nonlinear dynamics & chaos, Springer-Verlag, 2003.
3. K. Alligood, T. Sauer, & James A. Yorke, Chaos: An Introduction to Dynamical Systems, Springer-Verlag, 1996.
4. M. Tabor, Chaos and Integrability in Non-linear Dynamics, Wiley, 1989.
