A SUMMER COURSE

June 6- July 7

Math 4018
Understanding Nonlinear Dynamics

This course introduces the main concepts and applications of nonlinear dynamics to problems motivated by other sciences. It aims to provide the necessary mathematical background in dynamical systems, as well as techniques of analysis of difference and differential equations to undergraduate students who are interested in applied mathematics. The topics are introduced in a real motivated context and students will learn to manipulate the techniques with concrete applications and the assistance of a computer algebra.
The mathematical topics to be covered are:

- Finite-Difference equations: Linear and nonlinear. Methods of iteration. Steady states and their stability. Cycles and their stability. Chaos. Applications selected from populations of insects, neural networks, and biological oscillators.
- One-dimensional differential equations: Geometrical and algebraic analysis. Matrices: eigenvalues and eigenvectors. Applications selected from bacteria growth, models for ionic currents during action potentials (neuroscience models).
- Two-dimensional differential equations. Harmonic oscillators. The phase plane. Local stability analysis of two dimensional of nonlinear systems. Limit cycles. Applications selected from chemotherapeutic drugs, modifications of Lotka-Volterra predator-prey equations, and neural oscillators.
- Dynamics in three and more dimensions. Applications from neurobiology.
- Numerical methods and a computer algebra proficiency. Newton's method to locate equilibria. Location of cycles.
- Time series analysis. Nonlinear dynamics and data analysis. Some applications to biological systems.
- Introduction to modeling.

Text: ``Understanding Nonlinear Dynamics" by Daniel Kaplan and Leon Glass, Springer 1995.
Evaluation will be based in team projects and class participation.
Prerequisite: Background in Calculus.