

Nonlinear dynamics and Chaos

Credit points: 7.5 ECTS

Start date: First week in October

Level: PhD

Grading scale: Pass/Fail

Teacher: Eric Libby

Description

Nonlinear dynamics is an area of mathematics with a wealth of applications to biology and physics. This course will delve into the behavior of nonlinear systems, which often exhibit unpredictable and complex behavior. Unlike linear systems, whose outputs are directly proportional to their inputs, nonlinear systems can demonstrate a wide variety of phenomena, including sensitivity to initial conditions, bifurcations, and strange attractors. This course will explore the mathematical underpinnings of these phenomena, using both analytical and computational techniques. The purpose of this course is to provide an introduction to the topic as we work through a well-known textbook on the subject Nonlinear Dynamics and Chaos by Steven Strogatz. By the end of this course, students should be equipped to analyze and predict the behavior of nonlinear systems.

Below are a sample of the topics the course will likely cover.

- flows on lines and circles
- stability and bifurcation analyses
- limit cycles
- fractals
- oscillators
- chaos and strange attractors

We will also study many fun problems with enticing names including: “rabbits vs sheep”, “love affairs”, and “fireflies”.

Prerequisites

This course is an applied mathematics course with many examples taken from biology. Its intended audience is PhD students from mathematical and computational sciences. The main prerequisite is some comfort and familiarity with early university mathematics, especially differential equations. Also some familiarity with computer programming can be beneficial since we will be solving some equations numerically.

Course structure and examination

The course is likely to be offered weekly to minimize disruption and will go on for approximately two months. The course will include prepared lectures that introduce and explain key topics. Students will then work in small teams to solve weekly problem-solving assignments (which are the examination in this course). The pass/fail distinction will be determined by successful completion of the assignments. It is hoped that a diverse group of students will participate to share expertise and facilitate understanding.