Mathematical modeling, fall 2009

Lecturer
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Scope
10 cu.

Type
Advanced studies.

Contents
Click here for a list of the topics treated in the course.

Lectures
Weeks 37-43 and 45-51, Tuesday 14-16 B321, Thursday 14-16 B322. Two hours of exercise classes per week.

Exams and projects
There are two alternative ways to pass the course: by passing the exam or by doing a project.

- The exam is on Thursday 10 December 2009 from 13:15-16:00 in room B322 (the usual lecture room) and may cover all the material presented during the lectures.

Click here for an old exam that has actually been used. Note however, that the exam on Thursday 10 December may also contain questions about pattern formation or questions about growth and development. Still, the sample exam should give you some idea of what to expect.

Update: click here for the exam of (late) 10-12-2009, and here for the answers.

- The projects (listed below) are like an elaborate homework exercise. They involve numerical work as well, and each covers only a specific part of the material presented in the lectures. If you chose to do a project you need to do only one. The report on the project has to be handed in not later than the first week of February 2010.

Click here for the list of available projects. (NOTE: correction in project #4 has been added on 10/10/2010)

Bibliography

- Some basic background on dynamical system theory (local stability analysis, Poincaré-Bendixon theorem etc.) can be found in

- The MATLAB web-site hosts also guides and books illustrating the programme. In particular, a very useful reference for the MATLAB ODE suite is chapter 7 of
  - Cleve Moler, "Numerical Computing with MATLAB" (Copyright 2004, Cleve Moler).

- A good introduction to the dynamics of spatially structured populations (reaction-diffusion, traveling waves, pattern formation) can be found in

Lecture Notes

- Populations of interacting particles:
  Introduction, mono-molecular reaction, bimolecular reactions, reaction networks, and the principle of mass-action (unfinished)
  Notes on numerical integration of ODE’s
  Notes on time-scaling analysis
  Notes on predator-prey models
  Local stability analysis
  Elements from the theory of Poincaré and Bendixon
  The resource-consumer model of Gause

- Movement in space:
Movement in space (part 1)
Density-dependent diffusion in the SIS model
Density-dependent diffusion and taxis in a resource-consumer model
Traveling waves (SIS model)
Traveling waves (Allee affect)
Pattern formation (diffusion vs taxis)
Pattern formation (diffusion vs taxis; summary)
Pattern formation (diffusive instability)
Pattern formation (diffusive instability; example)

Growth and development:
The transport equation and the renewal equation
Delay-differential equations
Fixed delays
Distributed delays

Exercise groups

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Exercises 1-5, Exercises 6-8, Exercises 9-11, Exercises 12-14, Exercises 15-16, Exercises 17-19, Exercises 20-22

Software

1. Example of "main" code with "function handle" (depends on 4 and 5)
2. Example of "main" code with "anonymous function" (depends on 3, 4 and 5)
3. Example of anonymous function
4. Naive Euler matlab subroutine invoked by 1 and 2
5. Naive Runge-Kutta matlab subroutine invoked by 1 and 2
6. Simple MATLAB code for the diffusion equation in one-dimension