# Mathematical Models in Biology

Programme course

6 credits

Matematiska modeller i biologi

TATM38

Valid from: 2017 Spring semester

**Determined by**
Board of Studies for Chemistry, Biology and Biotechnology

**Date determined**
2017-01-25

## Main field of study
Mathematics, Applied Mathematics

## Course level
Second cycle

## Advancement level
A1X

## Course offered for
- Chemical Biology, M Sc in Engineering
- Biomedical Engineering, M Sc in Engineering
- Engineering Biology, M Sc in Engineering
- Chemical Biology
- Biomedical Engineering, Master's programme

## Specific information
This course cannot be included in the same degree as the course TATA51.

## Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

## Prerequisites
Courses in Analysis and in Linear Algebra

# Intended learning outcomes

During this course participants will learn to formulate, analyse and interpret mathematical models that are used in biology and biotechnical applications. The participants will learn both mathematics needed for building a model as well as modelling through formulating and solving basic models used in population dynamics, epidemiology and morphogenesis. After this course a student will be able to

- draw a phase portrait, find equilibrium points and perform stability analysis for one- and two-dimensional dynamical systems
- calculate and draw explicit solutions of two-dimensional linear systems and simple one-dimensional equations
- find equilibrium points and perform stability analysis for discrete one- and two-dimensional dynamical systems
- formulate and recognise PDE-models based on the continuity equation
- solve initial-boundary value problem for diffusion equations with the use of the method of separation of variables and the use of Fourier series
- recognise and solve several classical models in mathematical biology such as
    - logistic growth of population
    - model of chemostat
    - Lotka-Volterra type models för predator-prey and competing species
    - Keller-Segel-model for aggregation of slime molds
    - Turing model of diffusion driven instability in chemical reaction systems
- read and analyse other mathematical models in scientific literature

# Course content

Ordinary differential equations. Dynamical systems: phase portrait and linear stability of equilibrium points. Integrals of motion. Chemostat, Lotka-Volterra models for interacting populations and models of epidemics. Linear and nonlinear difference equations modelling populations. Continuity equation. Solving diffusion type equations through separation of variables and the use of Fourier series. Conditions for diffusive instability and a chemical basis for morphogenesis.

# Teaching and working methods

This course consists of lectures and problem solving sessions and of a project work presented in a written report.

# Examination

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|---|---|---|---|
| UPG1 | Project reports | 1.5 credits | U, G |
| TEN1 | Written examination | 4.5 credits | U, 3, 4, 5 |

## Grades
Four-grade scale, LiU, U, 3, 4, 5

## Department
Matematiska institutionen

## Director of Studies or equivalent
Jesper Thorén

## Examiner
Stefan Rauch

## Course website and other links
http://www.mai.liu.se/und/kurser/index-amne-tm.html

## Education components
Preliminary scheduled hours: 60 h
Recommended self-study hours: 100 h

## Course literature
Leah Edelstein-Keshet, Mathematical Models in Biology, SIAM Classics in Applied Mathematics 46, ISBN-13: 978-0-898715-54-5

# Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.