UMEÅ UNIVERSITY

Control theory (kontrollteori)

Credits: 7.5 ECTS
Course period: March-May 2026
Main field of study: Mathematics
Progress level: PhD
Grading scale: Pass/Fail
Course coordinator: Eric Libby (eric.libby@umu.se), Department of Mathematics and Mathematical Statistics

Prerequisites: The course is aimed at doctoral students in Mathematics or other disciplines applying computational or quantitative approaches. Students are expected to have basic knowledge of linear algebra and differential equations, as well as experience with scientific programming (e.g., MATLAB, Python, or Julia). Background knowledge in biology is beneficial, though not essential.

Objective: The course provides a theoretical and methodological foundation in control theory, with emphasis on how feedback, stability, and optimal decision-making can be used to analyze and design dynamical models, particularly in biological systems.

Contents: The course introduces fundamental concepts and methods of control theory, with an emphasis on feedback mechanisms in dynamical systems and their application to biological modelling. The course covers modelling, analysis, estimation, and control design for deterministic systems, with a focus on interpreting assumptions and limitations in applied contexts. Course topics include:

- modelling of dynamical systems in state-space form
- stability analysis of continuous-time systems
- feedback and closed-loop behaviour
- controllability and observability
- basic controller design (e.g., state feedback and proportional–integral control)
- introduction to optimal control and optimal decision-making

Form of instruction: Teaching consists of lectures, problem-solving, and self-study.

Examination: Examination is based on written problem sets/assignments completed during the course and submitted to the course coordinator.

Course literature:

Åström, K. J., & Murray, R. M. (2008). *Feedback Systems: An Introduction for Scientists and Engineers*. Princeton, NJ: Princeton University Press.
Frank, S. A. (2018). *Control theory tutorial: basic concepts illustrated by software examples*. Springer Nature.
Franklin, G. F., Powell, J. D., & Emami-Naeini, A. (2019). *Feedback Control of Dynamic Systems* (8th ed.). Pearson.