Introduction to Ordinary Differential Equations

Final Project – Fall 2025

General instructions. The project consists in writing a complete scientific report on an application of ordinary differential equations. The work is strictly individual, and each student must choose a different application. All mathematical statements must be justified; you may refer to results from the lectures without proof, provided the reference is precise. When numerical computations are used, the method and parameters must be stated, and the results must be interpreted in relation to the problem.

This project is an optional alternative to the written final exam. Students who choose to complete the project instead of the exam must inform the instructor by 20 December by sending an email to `richtf@usi.ch` with subject `[ODE] Final project - Student Name`, briefly describing the problem they intend to study, and then wait for confirmation before proceeding. The final report must be submitted by Friday 16 January at the latest, the peer-review report by 28 January, and grades will be communicated on 29 January.

Project outline. You should choose a concrete real-world system whose evolution over time can reasonably be described by an ordinary differential equation or a system of such equations. The report should be written in the style of a short scientific article and should normally contain the elements listed below.

Title. Use a descriptive title of the form "Modelling the dynamics of XXX: YYY", where XXX identifies the system or quantity you study and YYY is a short explanatory subtitle.

Introduction and problem description. Present the context and the practical question you wish to address. Explain why the problem is of interest and what aspects you intend to understand using an ODE model.

Mathematical model. Introduce the variables and parameters, state clearly the modelling assumptions, and derive the ordinary differential equation or system of equations. Comment briefly on the meaning and plausibility of the assumptions.

Analysis of the model. Study the qualitative behaviour of the model using techniques from the course (for example existence and uniqueness, equilibrium points, stability, and long-time behaviour), as appropriate for your problem.

Simulations and numerical results. When an explicit solution is not available, choose and implement a suitable numerical method. Present representative figures or tables, and explain how the numerical results illustrate or complement the theoretical analysis.

Conclusions. Summarise the main findings of your study. Discuss what the model tells you about the original problem, comment on its limitations, and, if relevant, indicate possible extensions.

Peer review. You will also write a short written evaluation of another student's project.

Evaluation. The project will be assessed according to the criteria summarised in the table below. The total is 100 points, including 10 points for the peer-review work described in the last row.

Criterion	**Description**	**Points**
Problem formulation	Clear explanation of the real-world problem and the objectives of the study.	10
Modelling	Well-justified mathematical model with explicit assumptions and a discussion of strengths and limitations.	15
Mathematical analysis	Correct and sufficiently deep analysis of the model using tools from the course and, where appropriate, existing literature.	20
Computational work	Reliable simulations and numerical results; all code in a public GitHub repository, documented and referenced in the report.	15
Scientific writing	Overall structure and presentation, including notation, readability, and quality of figures and references.	10
Ambition and completeness	Extent to which the work goes beyond the bare minimum requirements, exploring the problem in depth and presenting a coherent, complete report.	20
Peer review	Careful and useful written evaluation of another student's project; this affects only your own grade, not the grade of the student you review.	10