Differential Equations in Models

Title	Differential Equations in Models
Semester	F2024
Master programme in	Physics and Scientific Modelling
Type of activity	Course
Teaching language	English
Study regulation	Read about the Master Programme and find the Study Regulations at ruc.dk Læs mere om uddannelsen og find din studieordning på ruc.dk

REGISTRATION AND STUDY ADMINISTRATIVE

Registration	Sign up for study activities at stads selvbetjening within the announced registration period, as you can see on the Studyadministration homepage. When signing up for study activities, please be aware of potential conflicts between study activities or exam dates. The planning of activities at Roskilde University is based on the recommended study programs which do not overlap. However, if you choose optional courses and/or study plans that goes beyond the recommended study programs, an overlap of lectures or exam dates may occur depending on which courses you choose.
Number of participants	
ECTS	5
Responsible for the activity	Jesper Schmidt Hansen (jschmidt@ruc.dk) Johan Rønby Pedersen (johan@ruc.dk)
Head of study	Studieleder for Fysik (fys-sl@ruc.dk)
Teachers	
Study administration	INM Registration & Exams (inm-exams@ruc.dk)
Exam code(s)	U60195

ACADEMIC CONTENT

Overall objective	The objective is to give the students skills and competences to work with mathematical modelling and dynamic systems in general, including the mathematical concepts and theories that are included in the study of ordinary differential equations. The objective is to give the students proficiency in solving and analysing differential equations both with analytical and numerical methods.
Detailed description of content	The student will learn how to categorize differential equations, about solutions to systems of linear differential equations, and how knowlegde of linear systems can be used to perform a local analysis of non-linear differential equations (linear stability analysis). The student will see examples of different bifurcations and how these affect the behavior of dynamical systems. Finally, the curriculum may also include global methods; for example, null-cline analysis. In the course the student will explore dynamical models from different scientific fields, examples can include biological population models, chemical reactions, or/and the nonlinear pendulum. Numerical methods and analysis using Python, Matlab, or similar is an integral part of the course.
Course material and Reading list	The course syllabus is composed of lectur's notes and selected book chapters, for example, from "Differential Equations, Dynamical Systems, and an Introduction to Chaos" by Hirsch, Small and Devaney or similar. During the course, computer code will also be available; this code is not necessarily complete and the students must be able to extent and modify the code for specific purposes. Depending on the nature of the material, it will be made available to the students before and during the semester, for example, via the course moodle page.
Overall plan and expected work effort	The teaching format can be based on a scientific dialogue between the students and the course teacher, teacher's own presentation, working with exercises, student presentations, etc. The teacher will, of course, always highlight the most relevant points. For the dialogue to be fruitful, the student must prepare for each class; this

includes careful reading the text material, finish exercises, and other home work suggested by the teacher.

As a rule of thumb, the student should use 1-2 hours of preparation for every hour in class.

Total (minimum): 140 hours

- In class: approx 40 hours
- Preparation for class: 60-80 hours
- Take-home assignment: 40-50 hours

Format

The course includes formative evaluation based on dialogue between the students and the teacher(s).

Evaluation and feedback

Students are expected to provide constructive critique, feedback and viewpoints during the course if it is needed for the course to have better quality. Every other year at the end of the course, there will also be an evaluation through a questionnaire in SurveyXact. The Study Board will handle all evaluations along with any comments from the course responsible teacher.

Furthermore, students can, in accordance with RUCs 'feel free to state your views' strategy through their representatives at the study board, send evaluations, comments or insights form the course to the study board during or after the course.

Programme

In the beginning, the course focuses on linear differential equations using known concepts from linear algebra like eigenvectors and eigenvalues. From this foundation, the student will then obtain skills and knowledge of local analysis of non-linear differential equations. T

he student will see and explore examples of how the mathematical understanding of dynamical systems is applied to analyze models in different scientific areas eg. biology and physics.

ASSESSMENT

Overall learning outcomes

After completing the course the student will be able to

- demonstrate knowledge and understanding of fundamental concepts in mathematical modelling and dynamic systems in general
- knowledge and understanding of exemplary mathematical models, their basis, structure, characteristics, scope and validity
- knowledge and understanding of mathematical methods and theories typically used in connection with mathematical modelling
- analyse and use mathematical models and dynamic systems in general
- handle and use the symbolic mathematical language and the key mathematical concepts involved
- analyse and critically assessing available mathematical models in terms of scope, usability and relevance
- communicate with colleagues and laymen about mathematical models and dynamic systems, their properties and usability
- mathematical modelling
- independently identify and analyse exemplary mathematical models and dynamic systems.

Form of examination

Individual written take-home assignment

The character limit of the assignment is: 1,200-120,000 characters, including spaces.
The character limit includes the cover, table of contents, bibliography, figures and other illustrations, but exclude any appendices.

The students start writing the take-home assignment during the course. The duration is 7 days and may include public holidays. The submission deadline will be announced on study.ruc.dk.

Assessment: 7-point grading scale

Form of Re-examination	Samme som ordinær eksamen / same form as ordinary exam
Type of examination in special cases	
Examination and assessment criteria	The assignment is be based on an analysis of an existing dynamical model, or a dynamical model proposed by the student herself (and approved by the teacher). The evaluation of the assignment will be based on the student's skill to perform and convey, in-depth, the linear and non-linear analysis methods taught in the course, as well as numerical explorations as specified in the learning outcome.
Exam code(s)	Exam code(s) : U60195

Course days:

Hold: 1

Differential Equations in Models

time	05-03-2024 12:15 til 05-03-2024 16:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.1-089 - teorirum 27 (66)
Teacher	Jesper Schmidt Hansen (jschmidt@ruc.dk) Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time	07-03-2024 10:15 til 07-03-2024 12:00
location	27.1-089 - teorirum 27 (66)
Teacher	Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time 12-03-2024 12:15 til
12-03-2024 16:00
location 27.1-089 - teorirum 27 (66)
Teacher Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time 14-03-2024 10:15 til
14-03-2024 12:00
location 27.1-089 - teorirum 27 (66)
Teacher Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time 19-03-2024 12:15 til
19-03-2024 16:00
location 27.1-089 - teorirum 27 (66)
Teacher Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time 21-03-2024 10:15 til
21-03-2024 12:00
location 27.1-089 - teorirum 27 (66)
Teacher Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time 26-03-2024 12:15 til
26-03-2024 16:00
location 27.1-089 - teorirum 27 (66)
Teacher Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time 02-04-2024 12:15 til
02-04-2024 16:00
location 27.1-089 - teorirum 27 (66)
Teacher Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time	04-04-2024 10:15 til 04-04-2024 12:00
location	27.1-089 - teorirum 27 (66)
Teacher	Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time	09-04-2024 12:15 til 09-04-2024 16:00
location	27.1-089 - teorirum 27 (66)
Teacher	Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time	11-04-2024 10:15 til 11-04-2024 12:00
location	27.1-089 - teorirum 27 (66)
Teacher	Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time	16-04-2024 12:15 til 16-04-2024 16:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.1-089 - teorirum 27 (66)
Teacher	Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time	18-04-2024 10:15 til 18-04-2024 12:00
location	27.1-089 - teorirum 27 (66)
Teacher	Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time	23-04-2024 12:15 til 23-04-2024 16:00

location 27.1-089 - teorirum 27 (66)
Teacher Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models

time 25-04-2024 10:15 til
25-04-2024 12:00
location 27.1-089 - teorirum 27 (66)
Teacher Johan Rønby Pedersen (johan@ruc.dk)

Differential Equations in Models - Take-home assignment

time 27-05-2024 10:00 til
03-06-2024 10:00
forberedelsesnorm ikke valgt
forberedelsesnorm D-VIP ikke valgt

Differential Equations in Models - Take-home assignment (reexam)

time 19-08-2024 10:00 til
26-08-2024 10:00
forberedelsesnorm ikke valgt
forberedelsesnorm D-VIP ikke valgt