Dynamical Systems Analysis (Mandatory in MathBio / Elective in PSM / Advanced Mathematics)

Title	Dynamical Systems Analysis (Mandatory in MathBio / Elective in PSM / Advanced Mathematics)
Semester	F2023
Master programme in	Matematik / Mathematical Physical Modelling / Mathematical Computer Modelling / Mathematical Bioscience / Mathematical Bioscience / 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	Morten Andersen (moan@ruc.dk)
Head of study	Jesper Schmidt Hansen (jschmidt@ruc.dk)
Teachers	
Study administration	INM Registration & Exams (inm-exams@ruc.dk)
Exam code(s)	U41331 / U41560 / U60165

ACADEMIC CONTENT

Overall objective	The overall objective of the course is to give the student an advanced understanding dynamical systems and how analysis of these are constructed.
Detailed description of content	The course includes examples of dynamical systems (ordinary differential equartions) that arise in physics, chemistry and biology. The focus is on the mathematical analysis and mathematical properties of such dynamical systems. Systems of linear differential equations with constant coefficients are covered in detail, showing important applications of linear algebra. Methodology from analysis I and II is then used extensively for nonlinear systems of differential equations, leading to the proof of the contraction mapping theorem on Banach spaces which is used to prove the existence and uniqueness theorem. The focus is then on the qualitative behaviour of solution trajectories, involving Lyapunov stability and attractors. The expected outcome for the student is a solid mathematical understanding of dynamical systems and their qualitative properties, including stating, proving and contextualize theorems of dynamical systems
Course material and Reading list	The course will have a primary textbook which will be announced on moodle prior to semesterstart.
Overall plan and expected work effort	The teaching format is based on a scientific dialogue between the students and the course teacher, working with exercises, student presentations, etc. The teacher will, of course, highlight 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): 135 hours • In class: 40 hours • Preparation for class: 80 hours • Preparation for exam: 15 hours
Format	
Evaluation and feedback	The course includes formative evaluation based on dialogue between the students and the teacher(s). 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	Depending on the specific topic, the teacher, and the student group, the students will engage in a dialogue with the teacher and from this do exercises in groups or individually. The exercises will be based on pure mathematical analysis, computer-aided analysis, discussion in groups, with teacher, and so forth. The themes in this course are: Linear differential equations with constant coefficients, the matrix exponential, phase plane analysis, the contraction mapping theorem, existence and uniqueness theorem of nonlinear ordinary differential equations, definition of flow, Lyapunov stability of equilibria, attractors, applications within physics, biology and chemistry.

ASSESSMENT

Overall learning outcomes	After the course the student will be able to ● formulate mathematical analysis of non-linear differential equation systems, e.g., via phase plane analysis. ● perform local and global stability analysis. ● demonstrate in-depth knowledge about bifurcations and how these affect the dynamics in mathematical models. ● present results from the mathematical analysis in a clear and concise manner using mathematical formalism and reasoning. ● critically assess the mathematical methodology behind analysis of dynamical systems analysis
Form of examination	Individual oral exam based on a portfolio. The character limit of the portfolio is 1,200-120,000 characters, including spaces. Examples of written products are exercise responses, talking points for presentations, written feedback, reflections, written assignments. The preparation of the products may be subject to time limits. The character limits include the cover, table of contents, bibliography, figures and other illustrations, but exclude any appendices. Time allowed for exam including time used for assessment: 30 minutes. The assessment is an assessment of the oral examination. The written product(s) is not part of the assessment. Permitted support and preparation materials for the oral exam: All. Assessment: 7-point grading scale. Moderation: Internal co-assessor
Form of Re-examination	Samme som ordinær eksamen / same form as ordinary exam
Type of examination in special cases	
Examination and assessment criteria	Individual oral exam based on a portfolio constructed from a mini project and working with known exam questions during the course to build a portfolio for the oral exam.

The student begin the exam with a presentation, after the presentation there will be a dialogue between the student, assessor and co-assessor.

The assessment criteria of the written part

- formulate mathematical analysis of non-linear differential equation systems, e.g., via phase plane analysis.
- perform local and global stability analysis.
- demonstrate in-depth knowledge about bifurcations and how these affect the dynamics in mathematical models.
- present results from the mathematical analysis in a clear and concise manner using mathematical formalism and reasoning.
- critically assess the mathematical methodology behind analysis of dynamical systems analysis

The assessment of the oral exam is based on the student's ability to meet the criteria mentioned above and their ability to

- clearly present and communicate the scientific content of the portfolio
- engage in a scientific dialogue and discussion with the assessor and co assessor

Furthermore, whether the performance meets all formal requirements in regard to both for the written og oral exam

Exam code(s)	Exam code(s) : U41331 / U41560 / U60165

Course days:

Hold: 1

Dynamical Systems Analysis (MATHBIO)

time	07-02-2023 08:15 til 07-02-2023 12:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.1-089 - teorirum 27 (66)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis (MATHBIO)

time	14-02-2023 08:15 til 14-02-2023 12:00
forberedelsesnorm	ikke valgt

forberedelsesnorm D-VIP	ikke valgt
location	27.1-052 - lokale 2 (20)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis (MATHBIO)

time	21-02-2023 08:15 til 21-02-2023 12:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.2-054 - lokale 3 (40)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis (MATHBIO)

time	28-02-2023 08:15 til 28-02-2023 12:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.2-054 - lokale 3 (40)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis (MATHBIO)

time	07-03-2023 08:15 til 07-03-2023 12:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.1-089 - teorirum 27 (66)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis (MATHBIO)

time	14-03-2023 08:15 til 14-03-2023 12:00
forberedelsesnorm	ikke valgt

forberedelsesnorm D-VIP	ikke valgt
location	27.1-089 - teorirum 27 (66)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis (MATHBIO)

time	21-03-2023 08:15 til 21-03-2023 12:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.1-089 - teorirum 27 (66)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis (MATHBIO)

time	28-03-2023 08:15 til 28-03-2023 12:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.1-089 - teorirum 27 (66)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis (MATHBIO)

time	11-04-2023 08:15 til 11-04-2023 12:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.1-089 - teorirum 27 (66)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis (MATHBIO)

time	18-04-2023 08:15 til 18-04-2023 12:00
forberedelsesnorm	ikke valgt

forberedelsesnorm D-VIP	ikke valgt
location	27.1-089 - teorirum 27 (66)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis (MATHBIO)

time	25-04-2023 08:15 til 25-04-2023 12:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.1-089 - teorirum 27 (66)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis - Hand-in of portfolio (MathBio)

time	25-05-2023 10:00 til 25-05-2023 10:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt

Dynamical Systems Analysis - Exam (MATHBIO)

time	01-06-2023 08:15 til 01-06-2023 16:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
location	27.2-054 - lokale 3 (40)
Teacher	Morten Andersen (moan@ruc.dk)

Dynamical Systems Analysis - Hand-in of portfolio (reexam) (MathBio)

time	30-06-2023 10:00 til 30-06-2023 10:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt

Dynamical Systems Analysis - Reexam (MATHBIO)

time	14-08-2023 08:15 til 14-08-2023 16:00
forberedelsesnorm	ikke valgt
forberedelsesnorm D-VIP	ikke valgt
Teacher	Morten Andersen (moan@ruc.dk)