Roskilde University

Master of Science Physics and Scientific Modelling

Photo: Unsplash

"When are scientific models useful?

Master's Programme

Physics and Modelling

Physics and Scientific Modelling provides training in experimental, theoretical, and numeric methods to solve problems in physics and other fields. The weighting of experiments, theory and numeric techniques is determined by your choices in the study programme.

Scientific

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The point of departure is the understanding of physics and the laws of nature, but in this study programme, there is a special focus on independent work in identifying which physical concepts and mathematical and numerical methods that are relevant to solve a given problem. In the projects, it is possible to immerse yourself in experimental, computer science and / or mathematical aspects of modelling. At the same time, it is possible to apply the physics competencies outside of classical physics subjects if you want a clear interdisciplinary profile.

The aim of the study programme is to give you competencies and methods to work systematically and critically with physics, modelling and data science in connection with problems in a wide range of fields.

The programme can be tuned to give different profiles depending on how the elective courses are chosen and the type of projects the student works with. Particularly there is the option of following one of three predefined thematic profiles, while it is also possible to follow the programme with an individual profile based on combining elements from the thematic profiles or including other elements.

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Physics and Modelling

> **"At RUC, you do not only study in the traditional sense. At RUC you find a problem you want to solve, and then you acquire the skills and knowledge needed to solve it."**
>
> Rasmus Godiksen, Director, Head of Risk Management,
> EKF Denmark's Export Credit Agency

Scientific

The three predefined thematic profiles are:

Experimental and computational physics: The focus in this theme is on the practical implementation of physics and scientific modelling. This includes a focus on the process of acquiring data via experiments or scientific computing and on data analysis and data science.

Mathematical foundation of physics and scientific modelling: The focus in this theme is on the role of mathematics in modelling and gives insight into the mathematical way of thinking and how it differs from physics. The theme has a focus on logic and proofs and gives a classical academic profile which for example is relevant for teaching.

Experimental and computational biophysics: The theme is analogous to that of experimental and computational physics, but with a focus on data acquisition, analysis and modelling in the specific area of biophysics, biochemistry, and bioscience.

Example of a study programme

4. semester	Master Thesis (30 ECTS)			
3. semester	Problem Solving in Physics II (10 ECTS)	Elective/ Thematic course (5 ECTS)	Specialization Project /Project-oriented Internship (15 ECTS)	
2. semester	Problem Solving in Physics I (5 ECTS)	Elective course (10 ECTS) / Thematic course and elective course (5 + 5 ECTS)	Differential Equations in Models / Dynamical Systems (5ECTS)	Scientific Computing and Data Science / Fundamental Mathematical Structures (10 ECTS)
1. semester	Experiments and Models - Linear Response: Structure and Dynamics of Condensed Matter (10 ECTS)	Statistical Physics with Scientific Programming (5 ECTS)	Modelling Project (15 ECTS)	

Please note: The table shows an example of a course of study. Courses, projects, internships and studies abroad with credit transfer may vary for each student.

Elective and thematic courses

2 semester				
Integrated Science (5 ECTS)	Probability and Statistics (5 ECTS)	Scientific Computing and Data Science (10 ECTS)	Fundamental Mathematical Structures (10 ECTS)	Biophysical Chemistry (5 ECTS)

3. semester			
Parameter Estimation (5 ECTS)	Differential Geometry (5 ECTS)	Proteomics and Metabolomics (5 ECTS)	Advanced Physics (5 ECTS)

Each semester, the study board may approve additional elective courses which are available to students.

1. SEMESTER

Through exemplary work in a semester project and mini-project based courses you will get experience with and knowledge about the interplay between experiment, theory, models and numerical methods in physics and scientific modelling. The courses cover both experimental and computational skills while the project can be tuned in a theoretical, experimental, or computational direction depending on your interest.

2. SEMESTER

The second semester is the profiling semester where you start working with the thematic profile of choice or begin designing your individual profile. You may dive into fundamental mathematical structures and/or develop your skills in scientific computing and data science. In this semester you can also choose the course biophysical chemistry or choose courses in other branches of science to create an interdisciplinary profile.

3. SEMESTER

In the third semester the course problem solving in physics II serves as a culmination of the training in working with modelling in a problem-solving context. You will learn to tackle an openly formulated problem, formulate it in terms of physics and mathematics, solving the problem and evaluating the solution. The semester is also your specialisation semester where you via the project and a profile/elective course develop your profile further. This may include internships and/or preparatory studies for your master thesis.

4. SEMESTER

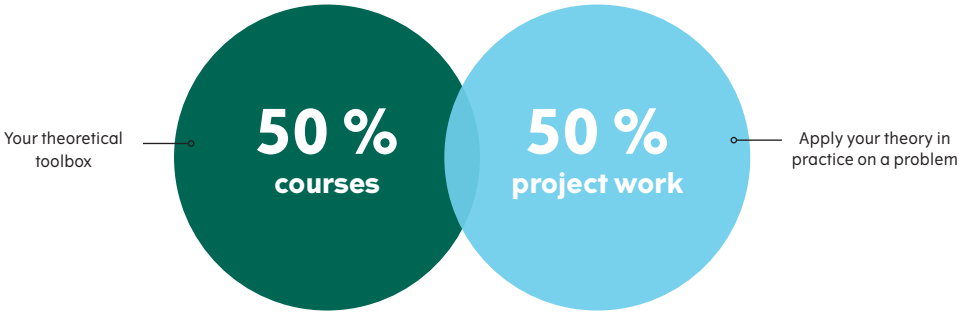
The objective of the master's thesis is that you reach the research front in a selected area within physics and/or scientific modelling, the mathematical foundation of physics and scientific modelling, or in another field where thinking as a physicist and/or scientific modelling plays a role in advancing the field. You will be making independent methodological choices and conduct experimental, computational and/or analytical work to solve a scientific problem. The master's thesis also serves as your final specialization before graduating.

Form of Study

Through your education, you get the opportunity to create your own individual education profile and your own independent specialization in accordance with the idea of the problem-oriented, interdisciplinary and project-oriented teaching method at Roskilde University.

THE STUDY FORM IS A COMBINATION OF

- Problem-oriented project group work
- Courses that are organized as teaching in small groups, where the focus is on theories, methods, and problems in an interaction between teacher and student



The project work and guidance are prioritized at Roskilde University. We also prioritize that you gain experience with the production and processing of empirical data as well as the practical application of theories and methods.

All master's programmes offer project-oriented internships and / or studies at other universities at home and abroad with credit transfer.

Project Examples

- How does the self assembly of the ABC miktoarm star terpolymer thin films look in-silico using Dissipative Particle Dynamics?
- To what extend is it possible to categorize mathematical proofs in terms of the strategies and techniques used to derive them?
- How does experimental data on fire front propagation of discrete fuel beds compare to existing models?
- What is the status of the experimental tests of Bell's Inequality today and what can we conclude about the debate between Bohr and Einstein?
- Do molecular dynamics simulations of UO_2 crystals give evidence for isomorphs?
- Under what conditions will Ice Slabs be formed in the GEUS Surface Energy Balance and Firn Model?
- How can differential dynamic microscopy be used to characterize colloidal dispersions?
- What is the vorticity topology of the core-growth model in the case of two vortices in a Couette flow?
- Can the time evolution of the dielectric properties be used to understand the embrittlement of candidates for sustainable LEGO-material substitutes?

Competences

The master's programme in Physics and Scientific Modelling will give you a strong professional position in the labor market and a solid starting point for research. The programme will enable you to:

- Apply knowledge of fundamental theories of physics in problem solving
- Tackle an openly formulated problem by reformulating it in terms of physics and mathematics, solving the problem and evaluating the solution
- Plan and structure a scientific research projects with the relevant experimental, analytic and/or numerical strategies
- Carry-out experiments, and model and evaluate the output data.

Career examples

Senior Engineer | Hempel A/S

Forecast Analyst | Dong Energy

Industry Technology Specialist | Novozymes

Physics and Mathematics High School Teacher | Roskile Katedralskole

Professor | DTU (Danish University of Technology)

Lead Data Scientist | VITAL BEATS

Project Manager | Danish Road Directorate

Quant | Danske Bank

”As a physicist, the professional challenge will always weigh heavily - but I could not imagine working on something that does not make an actual difference in the real world. This is also something I have taken with me from RUC.”

Ditte Gundermann, Senior Engineer, Hempel A/S

Further information

You can find admission requirements, application deadlines and other information about Physics and Scientific Modelling at Roskilde University here:

ruc.dk/en/master/physics-and-scientific-modelling

Contact us if you have questions about Physics and Scientific Modelling:

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Published by
Roskilde University
Department of Science and Environment

Layout
RUC Communication & Press

Print
LaserTryk

January 2022

Tryksag
5041 0826
LaserTryk.dk

FSC
www.fsc.org
MIX
Papir fra ansvarlige kilder
FSC® C010493