Master program in Computational Physics, Mathematics and Life Science

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Master program in Computational Physics, Mathematics and Life Science

The program is a collaboration between five departments and classical disciplines:

- Department of Biosciences
- Department of Chemistry
- Department of Informatics
- Department of Mathematics
- Department of Physics

The program is truly multidisciplinary and all students who have completed undergraduate studies in science and engineering, with a sufficient quantitative background, are eligible.

The new program combines old and new initiatives

This program builds on the strengths and successes of two existing Master of Science programs/directions at the University of Oslo, namely the

- Computational Physics (at the Dept. of Physics) and
- Applied Mathematics and Mechanics (at the Dept. of Mathematics).

These programs/study directions were established in 2003. Based on the experience from these programs, the hope is that the proposed program can enlarge the reach of disciplines where computations play and/or are expected to play a large role. In particular, new directions in Computational Life Science need to be developed to meet coming needs of the scientific community. We believe this new direction is best developed in close collaboration with already successful computational science programs.

Thesis directions

The program aims at offering thesis projects in a variety of fields. These are

- Computational mathematics
- Computational mechanics and fluid mechanics
- Computational chemistry
- Computational physics
- Computational materials science

- Computational life science
- Computational informatics and big data
- Image analysis and signal processing
- Computational finance and statistics
- Computational geoscience

The thesis projects will be tailored to the student's needs, wishes and scientific background. The projects can easily incorporate topics from more than one discipline and can be linked up with companies from public and private sector.

Recruit widely

The following higher education background qualifies for this program:

- A completed bachelor's degree (undergraduate) comparable to a Norwegian bachelor's degree in one of the following disciplines
  1. Biology, molecular biology, biochemistry or any life science degree
  2. Physics, astrophysics, astronomy, geophysics and meteorology
  3. Mathematics, mechanics, statistics and computational mathematics
  4. Computer science and electronics
  5. Chemistry
  6. Materials Science and nanotechnology
  7. Any undergraduate degree in engineering
  8. Mathematical finance and economy
  9. Economy
- There is a requirement on average mark and credits in mathematics and computer science.

Strategic importance

- The program will educate the next generation of cross-disciplinary science students with the knowledge, skills, and values needed to pose and solve current and new scientific, technological and societal challenges.
- The program will lay the foundation for cross-disciplinary educational, research and innovation activities at the Faculty.
- The program will contribute to building a common cross-disciplinary approach to the key strategic initiatives at the Faculty: Energy, Materials, Life Science, and Enabling Technologies.

Strategic importance

A specific aim of this program is to develop the students' ability to pose and solve problems that combine physical insights with mathematical tools, experiment (where appropriate) and computational skills. This provides a unique combination of applied and theoretical knowledge and skills. These features are invaluable for the development of multi-disciplinary educational and research programs.

Scientific and educational motivation

Numerical simulations of various systems in science are central to our basic understanding of nature and technlogy.

The increase in computational power, improved algorithms for solving problems in science as well as access to high-performance facilities, allow researchers nowadays to study complicated systems across many length and energy scales.

Applications span from studying

- quantum physical systems in nanotechnology and the characteristics of new materials or subamotic physics at its smallest length scale, to simulating galaxies and the evolution of the universe.
- In between, simulations are key to understanding cancer treatment and how the brain works,
- predicting climate changes and this week's weather,
- simulating natural disasters, semi-conductor devices,
- quantum computers,
- as well as assessing risk in the insurance and financial industry.

These are just a few topics already well covered at the University of Oslo and that can be topics for coming thesis projects as well as research directions.

The new program will also host the CSE project

- The new proposed program will also take a leading responsibility in further developments of the highly successful Computing in Science Education initiative at UiO.
- Master of science thesis projects linked up to the CSE project will be offered.

Computing competence

Computing means solving scientific problems using computers and all other possible tools.

It covers numerical as well as symbolic computing. Computing is also about developing an understanding of the scientific process by enhancing algorithmic thinking when solving problems. Computing competence has always been a central part of the science and engineering education.

Modern computing competence is about

- derivation, verification, and implementation of algorithms
- understanding what can go wrong with algorithms
- overview of important, known algorithms
- understanding how algorithms are used to solve mathematical problems
- reproducible science and ethics
- algorithmic thinking for gaining deeper insights about scientific problems

Structure and courses

The table here is an example of a suggested path for a Master of Science project, with course work the first year and thesis work the last year.

	10 ECTS	10 ECTS	10 ECTS
4th semester	Master thesis	Master Thesis	Master Thesis
3rd semester	Master thesis	Master Thesis	Master Thesis
2nd semester	Master courses	Master courses	Master courses
1st semester	Master courses	Master courses	Master courses

Structure and specialized modules

The program allows also for replacing regular courses with specialized modules of shorter duration. These modules will be developed by the program committee but can also be developed in an ad hoc basis and tailored to the individual projects.

	10 ECTS	10 ECTS	10 ECTS
4th semester	Master thesis	Master Thesis	Master Thesis
3rd semester	Master thesis	Master Thesis	Master Thesis
2nd semester	Special module	Special module	Special module
1st semester	Special module	Special module	Special module

The program opens up for flexible backgrounds

While discipline-based master's programs tend to introduce very strict requirements to courses, we believe in adapting a computational thesis topic to the student's background, thereby opening up for students with a wide range of bachelor's degrees. A very heterogeneous student community is thought to be a strength and unique feature of this program.

Career prospects

Candidates who are capable of modeling and understanding complicated systems in natural science, are in short supply in society. The computational methods and approaches to scientific problems students learn when working on their thesis projects are very similar to the methods they will use in later stages of their careers. To handle large numerical projects demands structured thinking and good analytical skills and a thorough understanding of the problems to be solved. This knowledge makes the students unique on the labor market.