COMPUTATIONAL SCIENCE AND ENGINEERING
Simulation at the heart of science

Nuclear fusion. Climate evolution. Nanoscale piling. Mathematical developments. What do these four science topics have in common? Computer simulations, where human genius - in making models and shaping up algorithms - and supercomputers meet. The master in computational science provides students with all the basic skills that will make them most wanted specialists in scientific computing, numerical methods, algorithmic and software engineering, visualisation and multiscale-multiphysics modeling.
Fusion Plasmas in a Tokamak

The International Thermonuclear Experimental Reactor (ITER) project aims to build an experimental tokamak which would allow to produce electricity from nuclear fusion reaction. This requires to confine plasma inside the reactor. At EPFL, ITER is represented by the Center for Research in Plasma Physics (CRPP).

Modeling and numerical simulations of the plasma allow to study its behavior before the completion of the reactor and without the risks and costs inherent to the first real experiments. Therefore, efficient numerical methods that can be implemented for parallel simulation on supercomputer are essential for such complex simulations.

website: http://crpp.epfl.ch/research_TCV

Multiscale Modeling of Materials

The mechanical deformation or the failure of a material, or the interaction between two objects, are characterized by phenomena at different space and time scales. The independent modeling of different scales has lead to important insights over the years. Thanks to modern supercomputers and advanced numerical schemes it is nowadays possible to better understand the interaction between scales. This relies on the coupling of continuum and discrete modeling and allows to understand involved mechanisms, for example, at the contact between two materials or at the origin of a fracture.

Dislocation emission during the normal contact loading of a nanoscale rough surface. The model benefits from a coupled method to reduce the computational cost involved in handling many atoms.

website: http://lsms.epfl.ch/

Vincent Zimmern: “EPFL has now this worldwide reputation for being a computationally very active place, with a lot of research going on.”

Dana Christen: “What I liked about EPFL is that it offered a good blend of theoretical courses and applied hands-on experiences.”

Watch the video:

Magnetic confinement of plasma in a Tokamak.

Boyancy and turbulence.
Master of Science in Computational Science and Engineering

2-year program - 120 ECTS

Core courses
24 ECTS
- Advanced numerical analysis
- Algorithms
- Computer simulation of physical systems I
- Dynamique moléculaire et simulations Monte Carlo
- Image processing I
- Introduction to multiprocessor architecture
- Machine learning
- Numerical analysis and computational mathematics
- Numerical integration of dynamical systems
- Parallel and high-performance computing
- Programming concepts in scientific computing
- Software engineering

Modeling and numerical methods
36 ECTS
- Computational modeling based on differential equations
- Advanced continuum mechanics
- Atomistic and quantum simulations of materials
- Biological modeling of neural networks
- Dynamical system theory for engineers
- Environmental transport phenomena
- Hydrodynamics
- Instability
- Numerical flow simulation
- Particle-based methods
- Principles and applications of systems biology
- Turbulence

In the Modeling and numerical methods group, students have to choose 3 out of the 4 lists and complete at least 8 ECTS in each of them.

Internship

The program includes a compulsory 8-week internship which can be extended to 6 months and combined with the Master’s thesis.

Career prospects

EPFL is a world leader in computing, engineering and fundamental sciences. A Master in Computational Science and Engineering from EPFL opens the door to top employment with computational skills in a broad spectrum of industries, not only in all branches of engineering, but also in emerging and vibrant market sectors including energy, financial and pharmaceutical R&D. It is also a strong asset for a PhD in Computational Science.

School of Basic Sciences
go.epfl.ch/master-computational-science-engin
Contact: cse@epfl.ch