Computational engineering (CE)

Computer simulation is essential for success in international competition, because experiments are often too expensive, too slow, too dangerous or even impossible. In modern research and development in science and industry, therefore modelling, simulation and visualization with the help of high-performance computers has long been in use. FAU was the first to offer an international program in Computational Engineering and has been doing so since 1997. The basis of the program is an interdisciplinary education that combines mathematics, computer science and a specialization in engineering into a single degree program. The training provides a broad range of expertise and experience of working in groups and teams to research industrial projects.

The combined bachelor’s- and master’s program consists of a compulsory set of courses in computer science and applied (or technical) mathematics, a technical application field (TAF) chosen from the Faculty of Engineering (excluding computer science), and elective technical subjects. In the CE program, the TAF is central and has therefore significantly more weight than a subsidiary subject of the traditional kind. Thus, it becomes possible to teach fundamentals of a technical discipline to which computer science methods can then be applied fruitfully.

The master’s program is designed to allow students to pursue studies both in computer science and in an engineering field of their choice. For this reason, applicants are required to have knowledge in both of these areas. Ideally, students have either a bachelor’s degree in Computational Engineering or an engineering degree with a strong computer science component. A good mathematical background is essential. The program requires a minimum of 2 years of engineering mathematics at the university level. Additionally, knowledge in numerical mathematics is strongly recommended. The master’s program takes a minimum of four semesters. The main purpose of the last semester is the preparation of the master’s thesis. The thesis is intended to introduce students to research work at the university.
Application and Admission Requirements

- Completion of an excellent bachelor’s degree or a corresponding qualification in computer science, in a related scientific or technical field, or in mathematics.

- Proficiency and experience in both using and programming computers. Besides familiarity with the fundamentals of computers and computer science, we expect that you have solid programming experience with procedural languages like C and C++:
  - either more than 1000 hours of experience with programming in languages like C, C++, Fortran, Java, Python.
  - or more than two university courses in computer science out of the fields data structures and algorithms, programming, theoretical or technical computer science. Please list the corresponding courses in your application.

- A well-rounded education in engineering mathematics: besides the fundamentals of computers and computer science, we expect that you have solid programming experience with procedural languages like C and C++:
  - at least one university course from PDE, functional analysis, numerical analysis, discrete mathematics, optimization and statistics. Please list the corresponding courses in your application.

- Interest in learning how to use high performance computers to solve problems in engineering.

International Students

- Solid command of the English language – TOEFL score of at least 560 or equivalent qualification, e.g., confirmation of the university that the bachelor’s program had been taught in English.

- Should be interested to stay in Germany for at least two years.

Application: www.campo.fau.eu

General Structure

The master’s program in Computational Engineering consists of a seminar, the three sections mathematics, computer science and technical application field, and the master’s thesis (overall 120 ECTS). There is a standard study plan for each TAF. Nevertheless, in the master’s program most modules are elective. Students can choose modules from the CE module catalogue for the different master’s studies in the departments of computer science, engineering, applied mathematics, and physics.

Mathematics [≥ 20 ECTS].
Mathematics modules for the master’s program can be taken from CE module catalogue and are offered by the department of applied mathematics and from the different departments of the School of Engineering. The modules must have a mathematical orientation.

Computer Science [≥20 ECTS].
The students can select modules from CE module catalogue offered by the computer science research groups for the master’s program in computer science.

Technical Application Field [≥20 ECTS].
In this section the student can select modules from CE module catalogue offered by all master’s programs of the Faculty of Engineering. The only exception are modules from the department of computer science.

Seminar [5 ECTS].
The seminar part is only of one of the elective subjects mentioned above. Therefore, students can take a seminar of a master’s program from the department of computer science, the department of applied mathematics or a department of the Faculty of Engineering related to the TAF.

Master’s Thesis (30 ECTS).
The master’s thesis can be registered as soon as the student has successfully collected obtained 70 ECTS credit points. It has an extent of approximately 810 hours and must be completed within six months after the registration. The topic of the thesis must be related to subjects studied by the student during the master’s program. A special thesis advisor is usually assigned to each student. The thesis may involve regular meetings with the thesis advisor and also the participation in a larger research group. It can be written in English. An oral presentation of the results of about 30 minutes as well as a consecutive discussion are obligatory.

Technical Application Field (TAF)

The program in Computational Engineering offers a number of specialization areas, so-called Technical Application Fields (TAFs). Each student has to choose one of the following TAFs:

- Mechanics
  TAF Advisor: Prof. Dr. techn. habil. Stefan Rupitsch
  Contact: stefan.rupitsch@fau.de

- Computational Optics
  TAF Advisor: Prof. Dr.-Ing. Bernhard Schmauß
  Contact: bernhard.schmauss@fau.de

- Information Technology
  TAF Advisor: Prof. Dr.-Ing. Walter Kellermann
  Contact: walter.kellermann@fau.de

- Thermodynamics and Fluid Dynamics
  TAF Advisor: Dr.-Ing. Manuel Münch
  Contact: manuel.muench@fau.de

- Mechanics and Dynamics
  TAF Advisor: Dr.-Ing. Julia Mengheim
  Contact: julia.mengheim@fau.de

- Computational Material Science
  TAF Advisor: Dr. Paolo Moretti
  Contact: paolo.moretti@fau.de

- Medical Engineering
  TAF Advisor: Prof. Dr. Ing. Theo Haderlein
  Contact: theo.haderlein@fau.de

The academic and TAF advisors will assist applicants and students with their choice. Students with a bachelor’s degree in computer science or similar – i.e., without a special engineering subject – are requested to apply for the TAF Medical Engineering.

Double Degree Program

Students can obtain a second master’s degree from the Swiss cantonal University della Svizzera italiana (USI) in Lugano, Switzerland. There are no tuition fees for the double degree program. To receive this double degree, students must obtain a total of 120 ECTS with at least 30 ECTS from USI and 30 ECTS from FAU.

Lugano is the home of one of the largest supercomputing centers in the world (CSCS), combining strong research in the field of high performance computing with applications like medical engineering, energy science, and data analytics. In addition, the city and region are a beautiful place to live and it offer plenty of social activities for students.

Elite Degree Program (BGCE)

In winter 2004/2005, a special elite program has been launched in the framework of the Elite Netzwerk Bayern initiative. This top-level program explicitly addresses the most capable and dedicated students of the master’s program in Computational Engineering.

As an extension to the regular CE master’s program, the elite program requires independent admission. The admission procedure to the honors program is carried out during the first semester at FAU. The student is expected to achieve an average grade of 2.0 or better in the first semester (German grading system: best grade is 1.0, minimum grade to pass is 4.0). After a formal application, the applicant will be invited for an interview with the honors commission. Only if the honors board supports the application, admission into BGCE will be granted.

www.bgce.de