Computer Simulation for Science and Engineering (COSSE)

An International Double-Degree Master Programme
“CSE is devoted to the development and use of computational methods for scientific discovery in all branches of the sciences and for the advancement of innovation in engineering and technology. It is a broad and vitally important field encompassing methods of HPC and playing a central role in the data revolution.”

*Future directions in CSE education and research, Report of the SIAM-EESI Workshop, 2015*
The double degree programme is more than the sum of two, or more, excellent programmes:

- It combines the best of two, or more, universities
- It provides international experience both with respect to research and intercultural exchange
- It provides a coordinated curriculum
- The student obtains two degrees of the two universities
- The student gains competitive advantage for careers in industry and academia
- At all partners, you will find a long experience with international programmes in CSE
Master’s Programme COSSE:

“Computer Simulation for Science and Engineering”

- KTH Royal Institute of Technology Stockholm
- Technical University Berlin
- Delft University of Technology
The Consortium
• An average of **250 applicants per year**
• **89 registered students from 28 countries** of all continents over 7 years
• **62 graduated students by 2017**
• **66 % of graduated students currently with PhD positions** both within the consortium universities as well as for example: ETH Zürich, University of Melbourne, University of Leuven, Uppsala University, MIT, Cambridge and Oxford.
• **Company employment** includes Ericsson, BASF, IBM, Tata Steel, Alten, DeCode Genetics, HERE
COSSE Students’ Origin

Countries:
- Bangladesh
- China
- Hong Kong
- India
- Malaysia
- Mongolia
- Pakistan
- Singapore
- Vietnam
- Canada
- Germany
- Iceland
- Lithuania
- Netherlands
- Poland
- Slovakia
- Slovenia
- Russia
- Serbia
- Turkey
- Ukraine
- Belize
- Colombia
- Mexico
- Kenya
- South Africa
Structure of COSSE

- First year at home university (TU Berlin)
  - ca 45 credits basic courses: mostly compulsory
  - ca 15 credits preparation course for exchange: recommended

- Second year at host university (KTH or TU Delft)
  - 30 credits specialization courses: elective
  - 30 credits Master thesis (at university or at partners)

All courses are closely tied with the local master programmes in Applied and Computational Mathematics.
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<th>Compulsory courses</th>
<th>Elective courses</th>
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<td>Numerical Linear Algebra</td>
<td>Advanced Numerical Linear Algebra</td>
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<td>Numer Methods for Engineers</td>
<td>Nonlinear Optimization</td>
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<td>Scientific Computing</td>
<td>Variational Methods and Optimal Control</td>
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<td>Differential Algebraic Equations</td>
<td>Optimal Control of PDEs</td>
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<td>Project Numerical Analysis</td>
<td>Machine Learning I</td>
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<td>Numerical Mathematics II</td>
<td>Machine Learning II</td>
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Examples of Master Theses

- An algebraic multilevel Krylov solver for large scale sparse problems, *Rainer Hartmann (Germany)*
- The role of pairwise and higher-order correlations in feedforward inputs to neural networks, *David Hübner (Germany)*
- Numerical Reconstruction of Fundamental Solutions of the Stokes System with Finite Elements, *Jacob Snoeijer (The Netherlands)*
- Modeling turbulent two-phase stratified flow, *Berkcan Kapusuzoglu (Turkey)*
- Implementation of the Particle Mesh Ewald method on a GPU, *Alexei Iupinov (Russia)*
Examples of Master Theses

- Interaction waves for real-time ship simulation, Akash Mittal (India)
- A patient specific poroelastic model of a brain with a subdural hematoma, Carolyn Langen (Canada)
- Predicting Electromagnetic Noise in Induction Motors, Nguyen Minh Khoa (Vietnam)
- On the edge of regional climate models, Maria Kootte (The Netherlands)
- Impact of static sea surface topography variations on ocean surface waves, Yik Keung Ying (Hong Kong)
- Efficiency improvement of panel codes for the maritime industry, Yun Mei Eliza Ang (Singapore)
• The KTH Master’s Programme Scientific Computing was established in 1997
• Programme hosted by the Department of Mathematics since 2012
• Now part of the Master Programme Applied and Computational Mathematics
• Active Member of SeRC, the Swedish e-Science Initiative (a Strategic Research Area financed by VR)
• Master’s thesis in academia and at companies like ABB, Volvo PV, SAAB, Comsol, Biovitrum, Ericsson
• In the latest (2018) Shanghai ARWU ranking, the Math Department of KTH is ranked 22th
Technical University of Berlin

- Bachelor/Master programmes in Mathematical Engineering (Techno-Mathematik) and Scientific Computing established in 2006
- Main partner of the Research Centre MATHEON (“Mathematics for Key Technologies”)
- German Research Foundation Centre of Excellence (since 2002)
- Main partners: TUB, FUB, HUB, ZIB, WIAS
- Application-driven research in close collaboration with partners from industry, economy and science
- Most master’s thesis projects within this centre, in Interdisciplinary Priority Programmes, or in direct cooperation with industry partners
• Master programme in Applied Mathematics hosted by the Delft Centre for Computational Science and Engineering (interdisciplinary conglomerate of Delft research groups)
• Part of the 3TU Applied Mathematics Institute
• Many of the master’s thesis projects are carried out in research departments of large companies like Shell, Philips, Deltares, Marin, etc.
Some The First COSSE Graduates
• Meeting of all involved in COSSE
• Courses, lectures by world-known researches
• Industry visits
• Have fun!

• Topics:
  • 2011: Mathematics in Waterland (Delft)
  • 2012: Simulation in Health Care (Erlangen)
  • 2013: Mathematics and Papermaking (Stockholm)
  • 2014: Mathematics in Key Technologies (Berlin)
  • 2015: Ultrascale Simulation (Erlangen)
  • 2016: Mathematics and Energy (Delft)
  • 2017: COSSE Alumni Meeting
• **Coordinator:** KTH Stockholm, cosse-master@kth.se (Prof Dr Michael Hanke, Ms My Delby)

• **At TU Berlin:** Prof Dr Reinhard Nabben, nabben@math.tu-berlin.de

• **At TU Delft:** Prof Dr ir Cornelis (Kees) Vuik (c.vuik@tudelft.nl)

https://www.kth.se/en/studies/master/cosse