Programme syllabus

Master's Programme, Applied and Engineering Mathematics, 120 credits
Masterprogram, ingenjörstillämpad matematik
\textit{120.0 credits}

\textit{Valid for students admitted to the education from autumn 14 (HT - Autumn term; VT - Spring term).}

This is a translation of the Swedish, legally binding, programme syllabus.

\textbf{Programme objectives}

This master’s program (N5TeAM) is a Nordic master’s program given in cooperation by the five partners of the Nordic Five Tech consortium of universities consisting of: KTH, Aalto University, Helsinki, Chalmers University of Technology, Göteborg, Norwegian University of Science and Technology (NTNU), Trondheim, Technical University of Denmark (DTU), Lyngby.

The main objective of N5TeAM is to train students in Applied and Engineering Mathematics together with a wide range of interdisciplinary applications in industry and science.

\textbf{Knowledge and understanding}

A master’s student with a degree from the N5TeAM programme has:

\begin{itemize}
  \item qualified and broad knowledge in the field of Applied and Engineering Mathematics including techniques for mathematical modeling, analysis of mathematical models, and simulation,
  \item profound competencies in mathematical and computational disciplines which are applicable in industry, business world, and public administration,
  \item qualified knowledge in a certain area of applied mathematics which comes close to active areas of research and allows for actively taking part in research.
\end{itemize}

\textbf{Skills and abilities}

A master’s student with a degree form the N5TeAM programme has the ability to:

\begin{itemize}
  \item formulate mathematical models, choose suitable methods to investigate these models including the efficient use of computer tools,
  \item analyze different mathematical models within science and technology and work creatively, systematically and critically,
  \item find strategies for the solution of different types of mathematical models using knowledge about the possibilities and limitations of the different methods and tools,
  \item communicate effectively with professionals within applied and engineering mathematics as well as with persons working with different scientific-technological applications in an interdisciplinary context,
  \item communicate effectively with management as well as society at large using written and oral presentations,
  \item cooperate effectively with colleagues with different cultural backgrounds.
\end{itemize}

\textbf{Ability to make judgements and adopt a standpoint}

A master’s student with a degree from the N5TeAM programme can:

\begin{itemize}
  \item critically judge validity and limitations of results obtained from different types of mathematical models,
\end{itemize}
• identify the need for further knowledge in the field and take responsibility for keeping his/her personal knowledge up to date.

Beyond this, there are similar goals for Master’s degrees defined in the higher education ordinance.

Extent and content of the programme

The N5TeAM programme is a two-year (120 ECTS credits) master program on the advanced level (second cycle). The instruction language is English.

The first year can be taken at any of the partner universities and consists of conditionally elective core courses providing basic knowledge and skills but also preparing for the specialization (track) that the student follows during the second year. The second year is taken at another partner university. The following eight specializations are offered:

KTH
• biocomputing

Aalto
• numerical analysis

DTU
• applied mathematical analysis
• cryptology and coding theory

Chalmers
• stochastics
• PDE

NTNU
• computational and spatial statistics
• computational mechanics, geosciences, and geometric integration

Core courses and specialization courses comprise at least 90 ECTS credits. A requirement for the degree is the successful completion of a course providing complementary skills (Philosophy, Economy, Finance, Research Methodology, Management, etc.) in the amount of 7.5–10 ECTS (which are part of the above mentioned 90 ECTS). This course can be taken at either university. The concluding degree project within the chosen specialization comprises 30 ECTS credits.

Eligibility and selection

General admission requirements: A well executed Bachelor’s degree (BSc, BEng or corresponding) comprising 180 ECTS credits from a university approved by the Swedish authorities or accredited of an authorized organisation. Stable knowledge in written and spoken English. The applicant must present proof of knowledge in English.

See KTH general admission requirements for Master’s programmes:
http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/antagning/1.27192

Specific admission requirements: Prerequisites for the Master’s programme in Applied and Engineering Mathematics:

• The Bachelor degree must be from a university listed in the latest distribution of the International handbook of universities
http://www.unesco.org/iau/onlinedatabases/list.html
• A Bachelor’s degree of 180 ECTS in science (B.Sc.) or engineering (B.Eng.) or documented equivalent studies in mathematics and applied sciences such as physics. The applicant should have solid knowledge of the
following subjects: vector calculus, linear algebra, ordinary differential equations, numerical analysis, probability and statistics. In addition, a basic understanding of partial differential equations and knowledge and experience of a higher programming language are required.

- Knowledge in the English language should be documented in the form of achieved credits in one of the named internationally known language tests

Detailed credits requirements for the language test, and requirements about when and how the documentation should be sent in can be found at http://n5team.aalto.fi/

The selection is based on the collected evaluation of the following:

1. Recognition and quality of the home institution
2. Validity and contents of the degree(s)
3. Study success
4. Motivation
5. Language proficiency
6. Recommendations
7. Relevant work experience or other relevant activity (patents, publications, etc.)

**Implementation of the education**

**Structure of the education**

The duration of the academic year at KTH is 40 weeks. The academic year at KTH is divided into four periods. Each period is followed by an exam period. Apart from these exam periods, there are three re-exam periods.

For details about the structure of the academic year see http://www.kth.se/student/schema/1.1007?l=en_UK

The first year of the N5TeAM programme is carried out at the home university and is devoted to the conditionally elective core courses depending on the specialization that the student chooses. An individual study plan is constructed for each N5TeAM student.

The second year is carried out at the host university in a different country. The studies comprise specialization courses, elective courses and a degree project.

The figure below shows the mobility tracks defined. Other mobility tracks are not possible unless special reasons are given. Deviations from the predefined mobility tracks are subject to a decision by the consortium.

First year  Second year

Aalto ---> Chalmers, DTU, NTNU
Chalmers ---> Aalto, NTNU
DTU ---> KTH, NTNU
KTH ---> Aalto, NTNU
NTNU ---> Chalmers, DTU, KTH

**Courses**

The programme is course-based. Lists of courses are included in appendix 1.

For KTH courses the course goals, prerequisites, contents and examination requirements are found in the course syllabus in the Course and program directory on the KTH student web. For each study year of the program there is a course list.
Core courses and specialization courses comprise at least 90 ECTS credits. A requirement for the degree is the successful completion of a course providing complementary skills (Philosophy, Economy, Finance, Methodology, Management etc.) in the amount of 7.5–10 ECTS (which are part of the above mentioned 90 ECTS). This course can be taken at either university. The concluding degree project within the chosen specialization comprises 30 ECTS credits.

Courses are examined in many ways, for example by home assignments that are presented either using oral presentations or written reports, computer assignments, project work or traditional written exams.

After each course a student evaluation is performed and then analyzed by the course leader in the course analysis document, which is normally published on the web, see the KTH regulations for course analysis: http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/kursanalys

**Grading system**

Courses in the first and the second cycle are graded on a scale from A to F. A-E are passing grades, A is the highest grade. The grades pass (P) and fail (F) are used for courses under certain circumstances.

**Conditions for participation in the programme**

The student is required to make a course selection for the coming semester. This must be done according to the rules of the institution where the studies will be carried out. The student is responsible for having the recommended prerequisites. In a few courses, the number of places is limited and selection, for the students who applied in time, is done according to merits such as grades and credits. The selection is done at the course-giving institution/school.

At the start of each semester the student is required to make a study enrollment for the next semester.

For each course, the student shall, at the start of course, register for the course according to the rules of the institution giving the course.

**Choice of specialization**

Together with the Letter of Acceptance, each student will be assigned a mobility track. The division of the students into the different specializations is based, foremost, on the students’ preferences, and secondly on the results of the previous studies with the constraint of an even distribution of the students at each of the five universities.

**Promotion to second year**

In order to be promoted to the second study year, the student must have completed at least 45 ECTS credits from study year one.

Students who do not fulfill these requirements must – in cooperation with the CSC program office, make an individual course plan for continued studies.

**Recognition of previous academic studies**

Credits for studies at another university can be transferred. An application form can be found on the KTH Student pages.

The application form is submitted to the CSC Program Office.

For in-depth information about the KTH policy for credit transfer, see http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/prestationer/1.27200

**Studies abroad**

Study year 1 is taken at the home university in one country and study year 2 at the host university in another country.
Degree project

Students within the N5TeAM programme must complete an individual degree project which corresponds to 30 ECTS credits. In order to start the degree project, at least 60 ECTS credits of the total number of course credits must be completed, where 10 ECTS credits are from the student's specialization. The goal with the degree project is that the student should show the ability to independently carry out a degree project by using the knowledge and abilities acquired throughout the program. The degree project is carried out at the host university and is supervised by teachers from both the home university and the host university.

It is the responsibility of the student to find a suitable project task.

More information about the rules for degree projects at KTH can be found at http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/examensarbete/1.27212?l=en_UK

Degree

The student can, after completing the program, apply for the Degree of Master of Science (Two Years).

Guidelines for how the application is done can be found on KTH student web.

Conditions for the Degree of Master of Science (Two Years)

In order for a N5TeAM student to receive double degrees from both the home and host university, all courses in the individual study plan must be passed and the degree project must be deemed as passed by both the home and host university.

For N5TeAM students who have studied one of the two years at KTH, it is required that the student has fulfilled the degree ordinance and has completed courses comprising 60 ECTS credits at KTH. The degree project, carried out at the host university, must correspond to 30 ECTS credits.

N5TeAM students who fulfill all requirements are awarded the Degree of Master of Science (two years). The students must apply in order to receive the degree and show proof of his/her Bachelor degree (BSc, BEng or corresponding).

See also the KTH regulations at http://intra.kth.se/regelverk/utbildning-forskning/grundutbildning/examina/1.27227?l=en_UK

The application form for the degree is found at the personal menu at www.kth.se.

Appendix 1 - Course list
Appendix 2 - Programme syllabus descriptions
## Appendix 1: Course list

Master's Programme, Applied and Engineering Mathematics, 120 credits (TITMM), Programme syllabus for studies starting in autumn 2014

### General courses

### Year 1

#### Mandatory courses (75.0 credits)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA2205</td>
<td>Introduction to the Philosophy of Science and Research Methodology</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Track 1 and 2</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF2520</td>
<td>Applied Numerical Methods</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Track 1 and 2</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF2561</td>
<td>The Finite Element Method</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Track 2</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF2568</td>
<td>Parallel Computations for Large- Scale Problems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Track 1 and 2</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF2713</td>
<td>Foundations of Analysis</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Track 1 and 2</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF2736</td>
<td>Discrete Mathematics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Track 1,2</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF2743</td>
<td>Advanced Real Analysis I</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Track 1 and 2</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF2822</td>
<td>Applied Nonlinear Optimization</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Track 2</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF2940</td>
<td>Probability Theory</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Track 2</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF2950</td>
<td>Applied Mathematical Statistics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Track 1</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Supplementary information

You follow somewhat different courses depending on which university you will follow your second year.

1. Aalto University

2. NTNU - Trondheim

DA2205 has to be studied during the first or second year if an equivalent course has not be studied.
### Year 2

#### Mandatory courses (37.5 credits)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA2205</td>
<td>Introduction to the Philosophy of Science and Research Methodology</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SF259X</td>
<td>Degree Project in Scientific Computing, Second Cycle</td>
<td>30.0</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

#### Optional courses

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB2280</td>
<td>Molecular Modeling</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>BB2300</td>
<td>Computational Chemistry</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>BB2440</td>
<td>Bioinformatics and Biostatistics</td>
<td>7.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2404</td>
<td>Applied Bioinformatics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2431</td>
<td>Machine Learning</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SF2524</td>
<td>Matrix Computations for Large-scale Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SF2565</td>
<td>Program Construction in C++ for Scientific Computing</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SF2567</td>
<td>Project Course in Scientific Computing</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

#### Recommended courses

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD2435</td>
<td>Mathematical Modelling of Biological Systems</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>SK2530</td>
<td>Introduction to Biomedicine</td>
<td>6.0</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

#### Supplementary information

DA2205 has to be studied during the first or second year if an equivalent course has not be studied.
Appendix 2: Specialisations

Master's Programme, Applied and Engineering Mathematics, 120 credits (TITMM), Programme syllabus for studies starting in autumn 2014

This programme has no specialisations.