Programme syllabus

Master's Programme, System-on-Chip Design, 120 credits
Masterprogram, systemkonstruktion på kisel
120.0 credits

Valid for students admitted to the education from autumn 13 (HT - Autumn term; VT - Spring term).

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

Programme objectives

For more than 30 years, integrated electronics has been the major new technological force shaping our everyday lives. Today's trend is that of shifting from personal computers to personal communication and computing, where system knowledge and expertise is now being encapsulated into single-chip solutions incorporating both hardware and software. This revolution is enabled and fuelled by deep submicron CMOS technologies, enabling gigascale integration.

A balanced Master's Programme is offered that includes all the key areas of knowledge and skills required to command the System-on-Chip technology, namely hardware design, embedded software design, analog circuit and radio design, systems engineering and extensive practical project work.

The programme is intended for senior undergraduate and first-year graduate students in electrical engineering and computer science. Key aspects are design methods, architectures and circuit design towards system level integration. The driving forces shaping the content and structure of the programme are:

Internationalisation: The atmosphere on the programme is truly international, with a mix of faculty, course assistants and students from all over the world.

Interdisciplinary approach: Our course mix gives a profound understanding of System-on-Chip design, ranging from deep submicron and noise issues to formal techniques and system modelling.

Practical competence: Small project assignments and hands-on lab sessions are included in the courses. The knowledge acquired in the courses will be transformed into practical competence in the master's thesis work.

Knowledge and understanding

Upon successful completion of the program the students shall

- Understand all important components of a System-on-Chip and an embedded system, i.e. digital hardware, analog hardware and embedded software;

- Know the major design flows for digital hardware, analog hardware and embedded software;

- Understand the major architectures and trade-offs concerning performance, cost and power consumption of single chip and embedded systems;

- Has mastered important examples of design languages, tools and techniques in two of these three domains;

- Appreciates the differences and commonalities of these three domains.
Skills and abilities
Upon successful completion of the program the students will be able to

- Design digital hardware;
- Design either embedded software or analog hardware;
- Use important examples of standard design languages and tools;
- Communicate design objectives, plans and results by means of reports and presentations to other SoC and embedded system engineers.

Ability to make judgements and adopt a standpoint
Upon successful completion the students will be able

- to critically read technical reports and design documents;
- to assess their strong and weak points;
- to formulate their assessment in concrete and constructive terms.

Extent and content of the programme
The program is a two year, 120 higher education credit education.

The program offers two informal tracks:

- ASIC/SoC Designer track has the main focus on ASIC/SoC design, digital, analog, or analog mixed signal design;
- Embedded Electronics track has the main focus on system design, embedded hardware, and embedded software;

The instruction language is English in all courses.

Eligibility and selection

General requirements

1. Previous studies

A completed Bachelor's degree, equivalent to a Swedish Bachelor's degree (180 higher education credits), from a university recognized by government or accredited by other recognized organization. A Bachelor's degree in Science or Engineering is required for most programmes (please see the relevant programme description).

Applicants admitted to longer technical study programmes and who have completed courses equivalent to an amount of 180 higher education credits, will be considered on a case-by-case basis.

2. Language requirements

A good knowledge of written and spoken English.
Equivalent to Eng B.

Applicants must provide proof of their proficiency in English. KTH accepts

TOEFL paper based test, total of 575, 4.5 writing section
TOEFL internet based test, total of 90, 20 writing section
IELTS score of at least 6.5, no band lower than 5.5 (only academic training accepted)

English proficiency tests are waived for applicants with English as language of instruction (minimum 3 years of full-
time higher education studies).

Knowledge of English may be taken into account in the selection process.

**Specific requirements**

Bachelor's degree in Electrical Engineering or Computer Engineering, or an equivalent degree, including a combination of courses equivalent to at least an extent of 60 higher education credits in: Microelectronics, Electronics, Computer engineering, Computer science, Automation and Control, or Communication engineering.

The specific requirements may be assessed as not fulfilled if;
- the average grade is in the lower third on the grading scale used (above pass level)
- the degree awarding institution is not considered to meet acceptable quality standards by the authorities of the country in which the institution is located
- the degree does not qualify for admission to equivalent Master level in the country where the degree is awarded.

**Selection**

Students who have met the undergraduate course requirements are evaluated and selected for the program based on their academic record including grades achieved in their courses, their English proficiency test scores, their motivation letter, and their letters of reference. Consideration may also be given for relevant work experience. All other admission requirements and criteria for the programme, including proofs of English proficiency, are in accordance with the local admission policy of the Royal Institute of Technology.

**Implementation of the education**

**Structure of the education**

In year 1 many of the courses are compulsory and many are shared between the two tracks. The basic concepts of SoC, embedded systems, and circuit technology are introduced. Year 2 is dominated by specialized courses and design projects. It concludes with a master thesis project.

**Courses**

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

90 higher education credits are compulsory and for the remaining 30 higher education credits there are courses with 120 higher education credits in total to choose from. Appendix 3 also shows which courses are compulsory and elective in the two tracks.

**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**

Study enrolment is made before each term and courses are chosen by the student prior to the second term of the first year and prior to each of the two terms of the second year. The choice is limited to the courses stated in the course list. Students announce their participation in an individual course to the teacher responsible for the course in the beginning of the course. Students announce possible interruptions in their studies to the teacher responsible for the course. A student is allowed to start the second year of studies after promotion to the second year. The condition for promotion to the second year is completion of 45 higher education credits in the first year.
Recognition of previous academic studies

Brief description of the conditions of receiving credit for previous studies according to the policy of the Royal Institute of Technology.

Policy on credit transfer for higher education courses including prior learning: Referring to KTH Regulation.

Studies abroad

The courses of the first year of the program should be followed at KTH, and the master’s thesis project in the second year may be performed at universities or companies abroad.

Degree project

In the master thesis project the student shall demonstrate that he/she is able to solve a given design or research problem largely on his/her own with limited guidance from the supervising teacher. In particular the student shall plan how to address the task, assess the difficulties of the individual steps, be able to make a realistic schedule for the project, identify obstacles and problems and suggest changes of the original task or plan if deemed necessary. The student shall demonstrate that he/she is able to find relevant, related work in the literature and to put his/her own work in perspective of other work. If the project includes the design of hardware or software, the student has to be able to demonstrate the correctness of the design. Relevant experiments have to be designed and conducted that allow the drawing of unambiguous and useful conclusions. Finally, the project has to be described in a well structured way in a report and a presentation. The project is graded on a scale from A to F. A-E are passing grades, A is the highest grade. The criteria for grading are, with equal weight, the technical content, the documentation and presentation of the work, and the process of conducting the project. The prerequisite to start the degree project is the successful completion of 60 credits of courses that are compulsory or elective in the chosen track.

Degree

The Master’s degree is obtained after completion of the courses and the thesis with a total of 120 higher education credits. The degree is ”Teknologie masterexamen”, translated into English as ”Degree of Master of Science (two years)”. The degree is awarded after application from the student.

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

Master's Programme, System-on-Chip Design, 120 credits (TSKKM), Programme syllabus for studies starting in autumn 2013

## General courses

### Year 1

### Mandatory courses (60.0 credits)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL2206</td>
<td>Embedded Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Both tracks</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL2212</td>
<td>Embedded Software</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Mandatory for Embedded Electronics, Conditionally Elective for ASIC/SoC Designer</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL2216</td>
<td>Media and Communication Electronics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Mandatory for Embedded Electronics, Conditionally Elective for ASIC/SoC Designer</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL2217</td>
<td>Digital Design with HDL</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Both tracks</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL2225</td>
<td>Embedded Hardware Design in ASIC and FPGA</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Both tracks</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL2226</td>
<td>Embedded System Design</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Mandatory for ASIC/SoC Designer, Conditionally Elective for Embedded Electronics</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL2227</td>
<td>VLSI Design Fundamentals</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Both tracks</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IL2450</td>
<td>System Level Validation</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Mandatory for ASIC/SoC Designer, Conditionally Elective for Embedded Electronics</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Conditionally elective courses

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>EK2350</td>
<td>Microsystems Technology</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Both tracks</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID2218</td>
<td>Design of Fault-tolerant Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Both tracks</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II2302</td>
<td>Sensor Based Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>Both tracks</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Course code
### Course name
### Credits
### Edu. level

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
</table>
| IL2205      | Applied Signal Processing  
  *Both tracks* | 7.5     | Second cycle     |
| IL2208      | Electronic System Packaging  
  *Both tracks* | 7.5     | Second cycle     |
| IL2218      | Analog Electronics, Advanced Course  
  *Both tracks* | 7.5     | Second cycle     |
| IL2220      | Low Power Analogue and Mixed Signal ICs  
  *Both tracks* | 7.5     | Second cycle     |
| IS2202      | Computer Systems Architecture  
  *Embedded Electronics* | 7.5     | Second cycle     |

### Year 2

#### Mandatory courses (22.5 credits)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
</table>
| EH2760      | Management of Projects  
  *All tracks* | 6.0     | Second cycle     |
| II2202      | Research Methodology and Scientific Writing  
  *All tracks* | 7.5     | Second cycle     |
| IL2228      | Design Project Course I                                  | 9.0     | Second cycle     |

#### Conditionally elective courses

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
</table>
| ID2202      | Compilers and Execution Environments  
  *Embedded System-on-Chip Platforms* | 7.5     | Second cycle     |
| IL2209      | Advanced Logic Design                                     | 7.5     | Second cycle     |
| IL2219      | Radio Electronics  
  *ASIC/SoC Designer, Communication Electronics* | 7.5     | Second cycle     |
| IL2221      | Advanced Topics in Mixed Mode Design  
  *All tracks* | 7.5     | Second cycle     |
| IL2452      | System Design Languages  
  *All tracks* | 7.5     | Second cycle     |
| IS2500      | RFID Systems  
  *All tracks* | 7.5     | Second cycle     |
Appendix 2: Specialisations

Master's Programme, System-on-Chip Design, 120 credits (TSKKM), Programme syllabus for studies starting in autumn 2013

This programme has no specialisations.