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 09 (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 fueled by deep submicron CMOS technologies, through which gigascale integration will be possible in the very near future.

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 sub micron 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.

The objectives (learning outcomes of the programme) should be presented according to the national degree ordinance in such a way that references to, or repetition of, the national degree ordinance are not required. The objectives should be structured under the following headings:

Knowledge and understanding

Upon successful completion of the program the students

- 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 are 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 are 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 three informal tracks:

- **SoC System & Architecture** track has the main focus on system design, system validation and embedded software;
- **SoC Circuit & Radio** track has the main focus on circuit design, analog mixed signal design and radio communication;
- **SoC Circuit Design & Technology** track has the main focus on circuit design, analog mixed signal design and circuit technology. This track is only given at Fudan University in Shanghai, China.

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 organisation. 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. Applicants must provide proof of their proficiency in English.

KTH accepts a TOEFL test score of a minimum of 550 (213 in the computer-based test, 79 in the internetbased test) or an IELTS score of at least 6.0, no band lower than 5.0 (both general and academic accepted).
English proficiency tests are waived for applicants with English as language of instruction (minimum 3 years of full-
time higher education studies).

For EU citizens from KTH’s partner universities, a certificate from the University language department or the relevant
Head of department stating the student's good level of English is sufficient. 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.

A good knowledge of English, equivalent to Eng B.

**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**

The programme is a two year programme; each year consists of four periods. Period 1: September/October for tracks
S&A, R&C; October/November for track CTDPeriod 2: November/December for tracks S&A, R&C; December
/January for track CTDPeriod 3: January/February for tracks S&A, R&C; March/April for track CTDPeriod 4: March
/April/May for tracks S&A, R&C; May/June for track CTD Each course is offered in one specific period. In some cases
a course stretched over two consecutive periods. In year 1 many of the courses are obligatory and many are shared
between the three 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. A schematic overview of all courses is
given in appendix 3. 90 higher education credits are obligatory and for the remaining 30 higher education credits there
are course with 120 higher education credits in total to choose from. Appendix 3 also shows which courses are
mandatory and elective in the three 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.

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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 who are term registered are considered as expected students in all chosen courses. 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. Reference the KTH-handbook policy.

**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 mandatory 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 "Teknologe 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 2009

General courses

Year 1

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>
<tbody>
<tr>
<td>IL1203</td>
<td>Design of Digital Integrated Circuits - LSI</td>
<td>7.5</td>
<td>First cycle</td>
</tr>
<tr>
<td>IL2206</td>
<td>Embedded Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2217</td>
<td>Digital Design with HDL</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
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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>II1206</td>
<td>ICT Venture Creation</td>
<td>15.0</td>
<td>First cycle</td>
</tr>
<tr>
<td>II2300</td>
<td>Product Realization Processes I</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>II2500</td>
<td>Product Realization Processes II</td>
<td>7.5</td>
<td>Second cycle</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>ID2218</td>
<td>Design of Fault-tolerant Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>II2302</td>
<td>Sensor Based Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2200</td>
<td>ASIC-design Methodology with High-level Languages</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2201</td>
<td>Design of Digital Integrated Circuits - VLSI</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2207</td>
<td>System-On-Chip Architectures</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2208</td>
<td>Electronic System Packaging</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2212</td>
<td>Embedded Software</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>Course code</td>
<td>Course name</td>
<td>Credits</td>
<td>Edu. level</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------------------------------------</td>
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</tr>
<tr>
<td>IL2216</td>
<td>Media and Communication Electronics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2218</td>
<td>Analog Electronics, Advanced Course</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2219</td>
<td>Radio Electronics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2220</td>
<td>Low Power Analogue and Mixed Signal ICs</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2450</td>
<td>System Level Validation</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IS2202</td>
<td>Computer Systems Architecture</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

### 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>
<tbody>
<tr>
<td>EH2720</td>
<td>Management of Projects</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>II2202</td>
<td>Research Methodology and Scientific Writing</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2213</td>
<td>Design Project Course I</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

**Conditionally elective courses**

<table>
<thead>
<tr>
<th>Course code</th>
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<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>II2300</td>
<td>Product Realization Processes I</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>II2500</td>
<td>Product Realization Processes II</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2209</td>
<td>Advanced Logic Design</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2216</td>
<td>Media and Communication Electronics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2221</td>
<td>Advanced Topics in Mixed Mode Design</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2223</td>
<td>Embedded Hardware Design</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2452</td>
<td>System Design Languages</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IS2500</td>
<td>RFID Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>
Appendix 2: Specialisations

Master's Programme, System-on-Chip Design, 120 credits (TSKKM), Programme syllabus for studies starting in autumn 2009

This programme has no specialisations.