Programme syllabus

Master's Programme, Embedded Systems, 120 credits
Masterprogram, inbyggda system
120.0 credits

Valid for students admitted to the education from autumn 18 (HT - Autumn term; VT - Spring term).

Programme objectives

Embedded Systems is the most common form of computer systems, i.e. those that are built into machines, devices and power and manufacturing plants, and therefore is not perceived as a computer system. Today, around 98 percent of all manufactured processors are used in embedded systems application, from sewing machines, to respirators, TV, power consumption measurement equipment and satellites. The common denominator for these embedded systems is high demands on functionality and reliability. The embedded systems are often real-time systems in the sense that they closely interact with the surrounding world that they control.

The enormous price/performance development for electronics coupled with the flexibility and programmability that the technology brings, means that new products and new functionalities in existing products are strongly increasing. This conveys large opportunities for innovation, company development and new enterprises.

The industry is at the same time experiencing severe problems with sustaining competence within the area and is also facing large challenges in managing the integration of software and hardware, to define suitable system architectures and to verify the products.

The purpose of the Master program is to give a broad education within Embedded Systems with a possibility to enter deeply and specialize within the areas (Embedded Electronics, Embedded Platforms, Embedded Software, and Embedded Control) covering theoretical as well as practical aspects for development of products based on Embedded Systems. Special weight is put on engineering skills, integration of software and hardware, system design, integration and verification, and the management of the design process.

Knowledge and understanding

Upon successful completion of the program the students shall

- Be able to design and evaluate the properties of an Embedded System.
- Have good knowledge of current research and development and industrial trends.
- Have good knowledge of processes, methods, and tools for development of Embedded Systems.
- Have a good foundation in Natural and Technical Science with a deepened understanding on an advanced level in one of the profiles of the program.

Skills and abilities

Upon successful completion of the program the students will be able to

- Show an ability that with a holistic approach be able to integrate knowledge, in an independent way and with a critical eye, identify and constrain, formulate and handle complex problems within the area.
- Show an ability to create technical solutions that fulfill human and societal needs.
- Show an ability to independently or within a group, plan and with adequate methods and tools, create relevant products and systems within given time frames, and evaluate this work.
Through his/her evaluation capability and style of being, be a good ambassador for KTH in industry and the world.

**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 its 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 four tracks:

- **Embedded Electronics track** has the main focus on the design of electronics in an embedded system, i.e., how sensors, AD/DA-converters and other components work, and how to design Printed Circuit Boards, ASICs and programming FPGAs. The student can study to become a specialist in the development of Sensor-based and Mixed-Signal Systems, (Multi-Processor) System-on-Chip (SoC) design, or building electronic gadgets for Internet-of-Things (IoT).

- **Embedded Platforms track** has the main focus on Embedded Platform - i.e., embedded hardware and its interaction with embedded software - design. The student can study to become a specialist in the development of Embedded (Multi-core) DSP platforms, Embedded (Multi-core) Computer platforms, and Embedded (Multi-care) Control platforms.

- **Embedded Software track** has the main focus in software engineering of (Distributed) Embedded Systems, i.e., development, management and test of (Distributed) Embedded Software for Embedded (Multi-care) Platforms. The student can study to become a specialist in Embedded Real-Time (Control) SW and general Embedded (Multi-care) Computer SW.

- **Embedded Control track** has the main focus on design, management and development of (Distributed) Embedded Control Systems for applications in Automation, Mechatronics, and Robotics.

**International Dual Degree** For students that are interested in spending one year abroad, there is the possibility to do a Dual Degree i.e., by studying one year at KTH and one year on one of our partner universities (at present UESTC in China and Khalifa University in Dubai). Courses are chosen in agreement with the intended partner university.

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. Applicants must provide proof of their proficiency in English. KTH accepts
TOEFL paper based test, total of 575, with at least 4.5 in the writing section
TOEFL internet based test, total of 90, with at least 20 in the 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).

Swedish applicants should have a good knowledge of English, equivalent to English B.

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. At least 30 ECTS credits course work in mathematics, including calculus, linear algebra and mathematical statistics.

Pre-requisites all line of studies: Computer Architecture & Organization Basics, Electric Circuits Theory (equivalent to EI1202 or IE1206), a basic course in programming (preferably C/C++).

Special pre-requisites for Embedded Electronics track: Digital Design basics (equivalent to IE1204 or IE1205), a basic course in Analog Electronics (equivalent to IE1202), A basic course in VHDL or Verilog (equivalent to IL1331 VHDL-design) and Signal Theory (see adaption courses below), i.e., sufficient knowledge in math including Laplace and Fourier Transforms, and Mathematical Statistics is required.

Special pre-requisites for Embedded Platform track: Digital Design basics. A basic course in VHDL or Verilog (equivalent to IL1331 VHDL-design). For the DSP related courses, a course in Signal Theory is required (see adaption courses below), i.e., sufficient knowledge in math including Laplace and Fourier Transforms, and Mathematical Statistics is required.

Special pre-requisites for Embedded Software track: None, except good programming skills. A course in discrete mathematics is strongly recommended.

Special pre-requisite for Embedded Control-track: A course in basic Mechanics (equivalent SG1102). For the control related courses, a course in Control Theory is highly recommended (see adaption courses below), i.e., sufficient knowledge in math including Laplace and Fourier Transforms, and Mathematical Statistics is required.

Special pre-requisite for International Dual Degree, Khalifa Univeristy: Test result from performed GRE.

Special pre-requisite for International Dual Degree, UESTC: The same pre-requisites as for the track Embedded Electronics.

Adaption courses:

Students who want to study some courses within Embedded Electronics, Embedded Platforms, Embedded Control and/or DSP area need to have a basic course on VHDL-design (Verilog is also accepted), Analog Electronic basics (Operational Amplifiers), Control Theory and/or Signal Theory in their portfolio. Students that lack at most ONE of these courses may study it upon arrival.

The specific requirements may be assessed as not fulfilled if:

- 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
The selection process is based on the following selection criteria: University, previous studies (for instance GPA, grades in specific subjects and English), motivation for the studies (for instance letter of motivation, references, thesis proposal and relevant work experience). The evaluation scale is 1-75.

**Selection for International Dual Degree**

To be eligible for International Dual Degree, the student must, in addition to KTH's requirements, also fulfill the demands/requirements of the indented partner university.

**Implementation of the education**

**Structure of the education**

In year one many of the courses are compulsory. All tracks study Embedded Systems, while taking the compulsory courses of each specific track. The basic concepts of embedded systems are introduced. Year two 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, up to a total of 120 higher education credits, courses can be selected freely from the program 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**

Student chose a track and potential adaption courses at application time, before arrival to the program. Track Courses are chosen by the student prior to the second quarter and 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.

**Course registration**

Course registration is compulsory and should be done via the personal menu at KTH.se at the beginning of each course. Students announce possible interruptions in their studies to the teacher responsible for the course.

**Conditions for further studies**

For students starting their education from the autumn semester 2018, previous promotion requirements have been replaced with special admission requirements to each course. Admission requirements are specified in the course syllabus.

**Recognition of previous academic studies**

Receiving credit for previous studies is done according to the policy of the Royal Institute of Technology.

**Studies abroad**

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

**Degree project**

The degree project is the final part of the education and comprises 30 higher education credits. The project work may begin when special admission requirements for the course are fulfilled.
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 degree project is graded P/F (Pass/Fail). In order to pass, the degree project must show high quality as tested against the relevant examination objectives, often all national examination objectives. Directives and criteria for passing and grading are available at https://intra.kth.se/styrning/regelverk/utbildning-pa-grund-och-avancerad-niva-1.660818. Specific directives and criteria for grading is available in the official course syllabus.

**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. Application for degree is made via the Personal menu at www.kth.se.

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

Master's Programme, Embedded Systems, 120 credits (TEBSM), Programme syllabus for studies starting in autumn 2018

General courses

Year 1

Mandatory courses (7.5 credits)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL2206</td>
<td>Embedded Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td>All Tracks</td>
<td></td>
<td></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>IL1331</td>
<td>VHDL Design</td>
<td>7.5</td>
<td>First cycle</td>
</tr>
<tr>
<td></td>
<td>Students that are studying IL2217 should not read this course</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>Students that are studying MF2044 do not have to read this course</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supplementary information

Mandatory courses in one track can be selected as elective courses for the other tracks.

All elective courses in year 1 can also be studied in year 2.

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>EH2760</td>
<td>Management of Projects</td>
<td>6.0</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></td>
<td>A course in research methodology, equivalent to II2202 or AK2036, is required in year 1 or year 2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MF2063</td>
<td>Embedded Systems Design Project</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>
Supplementary information
Degree project 30 credits advanced level is mandatory during the spring term.

Mandatory courses in one track can be selected as elective courses for the other tracks.

All elective courses in year 1 can also be studied in year 2.

Track, International Dual Degree, Khalifa University (INDD)

Year 1

Supplementary information
Courses for International Dual Degree, Khalifa University
The students follow one of the tracks within the programme.

Year 2

Supplementary information
Courses for International Dual Degree, Khalifa University
The students follow one of the tracks within the programme.

Track, International Dual Degree, UESTC, China (INDK)

Year 1

Supplementary information
Courses for International Dual Degree, UESTC
The students follow the track Embedded Electronics (INEL).

Year 2

Supplementary information
Courses for International Dual Degree, UESTC
Year 2 studies is located at UESTC, China.

Track, Embedded Electronics (INEL)

Year 1

Mandatory courses (45.0 credits)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>II2302</td>
<td>Sensor Based Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>At least one of II2302, IL2225 must be chosen.</em></td>
<td></td>
<td></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>
</tbody>
</table>
### Study Programme for Master's Programme, Embedded Systems, 120 credits batch autumn 18.

#### Course code

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL2225</td>
<td>Embedded Hardware Design in ASIC and FPGA</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2237</td>
<td>Electronic Systems Design</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2238</td>
<td>Fundamentals of Integrated Electronics</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>DD2459</td>
<td>Software Reliability</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EK2350</td>
<td>Microsystem Technology</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2218</td>
<td>Design of Fault-tolerant Systems</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>IL2219</td>
<td>Radio Electronics</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

*The course is currently under revision and may be replaced by a new course*

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL2236</td>
<td>Embedded Many-Core Architectures</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2239</td>
<td>Analog-Digital Interfaces</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>

#### 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>EQ1220</td>
<td>Signal Theory</td>
<td>7.5</td>
<td>First cycle</td>
</tr>
<tr>
<td>EQ2310</td>
<td>Digital Communications</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

*Prerequisites for courses in Signal Processing*

### Supplementary information

Mandatory courses in one track can be selected as elective courses for the other tracks.

All elective courses in year 1 can also be studied in year 2.

### 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>EH2760</td>
<td>Management of Projects</td>
<td>6.0</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>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>II2202</td>
<td>Research Methodology and Scientific Writing</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>MF2063</td>
<td>Embedded Systems Design Project</td>
<td>9.0</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>DD2425</td>
<td>Robotics and Autonomous Systems</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EK2360</td>
<td>Hands-On Microelectromechanical Systems Engineering</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EP2510</td>
<td>Advanced Networked Systems Security</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>II2300</td>
<td>Product Realization Processes I</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>
</tbody>
</table>

The course is currently under revision and may be replaced by a new course.

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<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>

**Supplementary information**

Degree project 30 credits advanced level is mandatory during the spring term.

Mandatory courses in one track can be selected as elective courses for the other tracks.

All elective courses in year 1 can also be studied in year 2.

**Year 3**

**Track, Embedded Software (INMV)**

**Year 1**

**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>DD2459</td>
<td>Software Reliability</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2202</td>
<td>Compilers and Execution Environments</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2207</td>
<td>Modern Methods in Software Engineering</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2206</td>
<td>Embedded Systems</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>
</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>DD2421</td>
<td>Machine Learning</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DT2140</td>
<td>Multimodal Interaction and Interfaces</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2450</td>
<td>Hybrid and Embedded Control Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2450</td>
<td>Recommended prereq. EL1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EP2500</td>
<td>Networked Systems Security</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EQ2341</td>
<td>Pattern Recognition and Machine Learning</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID1217</td>
<td>Concurrent Programming</td>
<td>7.5</td>
<td>First cycle</td>
</tr>
<tr>
<td>ID2010</td>
<td>Programming of Interactive Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2201</td>
<td>Distributed Systems, Basic Course</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2203</td>
<td>Distributed Systems, Advanced Course</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2203</td>
<td>Requires ID2201</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID2204</td>
<td>Constraint Programming</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2216</td>
<td>Developing Mobile Applications</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2218</td>
<td>Design of Fault-tolerant Systems</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>

### 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>IL1331</td>
<td>VHDL Design</td>
<td>7.5</td>
<td>First cycle</td>
</tr>
<tr>
<td>IL1331</td>
<td>Students that are studying IL2217 should not read this course</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Supplementary information

Mandatory courses in one track can be selected as elective courses for the other tracks.

All elective courses in year 1 can also be studied in year 2.

### 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>EH2760</td>
<td>Management of Projects</td>
<td>6.0</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>II2202</td>
<td>A course in research methodology, equivalent to II2202 or AK2036, is required in year 1 or year 2.</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>DD2425</td>
<td>Robotics and Autonomous Systems</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DT2140</td>
<td>Multimodal Interaction and Interfaces</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EP2510</td>
<td>Advanced Networked Systems Security</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EQ2415</td>
<td>Machine Learning and Data Science</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID1217</td>
<td>Concurrent Programming</td>
<td>7.5</td>
<td>First cycle</td>
</tr>
<tr>
<td>ID2201</td>
<td>Distributed Systems, Basic Course</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2213</td>
<td>Logic Programming</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>II2300</td>
<td>Product Realization Processes I</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>
<tr>
<td>IL2225</td>
<td>Embedded Hardware Design in ASIC and FPGA</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

### Supplementary information

Degree project 30 credits advanced level is mandatory during the spring term.

Mandatory courses in one track can be selected as elective courses for the other tracks.

All elective courses in year 1 can also be studied in year 2.

### Year 3

**Track, Embedded Platforms (INPF)**

#### Year 1

Mandatory courses (45.0 credits)

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD2459</td>
<td>Software Reliability</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td></td>
<td><em>One of DD2459 or IL2450 shall be chosen</em></td>
<td></td>
<td></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>
<tr>
<td>IL2225</td>
<td>Embedded Hardware Design in ASIC and FPGA</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></td>
<td><em>One of DD2459 or IL2450 shall be chosen</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course code</td>
<td>Course name</td>
<td>Credits</td>
<td>Edu. level</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------------------------------</td>
<td>---------</td>
<td>-----------------</td>
</tr>
<tr>
<td>IS2202</td>
<td>Computer Systems Architecture</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>EK2350</td>
<td>Microsystem Technology</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2450</td>
<td>Hybrid and Embedded Control Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EP2500</td>
<td>Networked Systems Security</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EQ2300</td>
<td>Digital Signal Processing</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EQ2310</td>
<td>Digital Communications</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EQ2330</td>
<td>Image and Video Processing</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<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>IL2236</td>
<td>Embedded Many-Core Architectures</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2238</td>
<td>Fundamentals of Integrated Electronics</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>ID2202</td>
<td>Compilers and Execution Environments</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>IL2237</td>
<td>Electronic Systems Design</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

**Supplementary information**

Mandatory courses in one track can be selected as elective courses for the other tracks.

All elective courses in year 1 can also be studied in year 2.

**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>EH2760</td>
<td>Management of Projects</td>
<td>6.0</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>
</tbody>
</table>

*A course in research methodology, equivalent to II2202 or AK2036, is required in year 1 or year 2.*
Course code | Course name | Credits | Edu. level
--- | --- | --- | ---
MF2063 | Embedded Systems Design Project | 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>
<tbody>
<tr>
<td>DD2423</td>
<td>Image Analysis and Computer Vision</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2425</td>
<td>Robotics and Autonomous Systems</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2437</td>
<td>Artificial Neural Networks and Deep Architectures</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EK2360</td>
<td>Hands-On Microelectromechanical Systems Engineering</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EP2510</td>
<td>Advanced Networked Systems Security</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2201</td>
<td>Distributed Systems, Basic Course</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2202</td>
<td>Compilers and Execution Environments</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>ID2207</td>
<td>Modern Methods in Software Engineering</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>II2300</td>
<td>Product Realization Processes I</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>

**Supplementary information**

Degree project 30 credits advanced level is mandatory during the spring term.

Mandatory courses in one track can be selected as elective courses for the other tracks.

All elective courses in year 1 can also be studied in year 2.

**Year 3**

**Track, Embedded Control (INSR)**

**Year 1**

**Mandatory courses (43.5 credits)**

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD2459</td>
<td>Software Reliability</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2320</td>
<td>Applied Estimation</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2450</td>
<td>Hybrid and Embedded Control Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2620</td>
<td>Nonlinear Control</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
</tbody>
</table>

At least one of EL2320, EL2620 must be chosen.

At least one of EL2620, EL2320 must be chosen.
### 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>
<tbody>
<tr>
<td>IL2206</td>
<td>Embedded Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>MF2030</td>
<td>Mechatronics basic Course</td>
<td>6.0</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>DD2421</td>
<td>Machine Learning</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EK2350</td>
<td>Microsystem Technology</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2520</td>
<td>Control Theory and Practice, Advanced Course</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2820</td>
<td>Modelling of Dynamical Systems</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<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>IL2212</td>
<td>Embedded Software</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>MF2007</td>
<td>Dynamics and Motion Control</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>MF2043</td>
<td>Robust Mechatronics</td>
<td>6.0</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>EL1000</td>
<td>Automatic Control, General Course</td>
<td>6.0</td>
<td>First cycle</td>
</tr>
<tr>
<td>IL1331</td>
<td>VHDL Design</td>
<td>7.5</td>
<td>First cycle</td>
</tr>
</tbody>
</table>

### Supplementary information

Mandatory courses in one track can be selected as elective courses for the other tracks.

All elective courses in year 1 can also be studied in year 2.

### 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>EH2760</td>
<td>Management of Projects</td>
<td>6.0</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>
</tbody>
</table>
A course in research methodology, equivalent to II2202 or AK2036, is required in year 1 or year 2.

<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Credits</th>
<th>Edu. level</th>
</tr>
</thead>
<tbody>
<tr>
<td>MF2063</td>
<td>Embedded Systems Design Project</td>
<td>9.0</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>DD2423</td>
<td>Image Analysis and Computer Vision</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2425</td>
<td>Robotics and Autonomous Systems</td>
<td>9.0</td>
<td>Second cycle</td>
</tr>
<tr>
<td>DD2437</td>
<td>Artificial Neural Networks and Deep Architectures</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EK2360</td>
<td>Hands-On Microelectromechanical Systems Engineering</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EL2620</td>
<td>Nonlinear Control</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>EQ2321</td>
<td>Speech and Audio Processing</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>II2300</td>
<td>Product Realization Processes I</td>
<td>7.5</td>
<td>Second cycle</td>
</tr>
<tr>
<td>IL2225</td>
<td>Embedded Hardware Design in ASIC and FPGA</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>IL1331</td>
<td>VHDL Design</td>
<td>7.5</td>
<td>First cycle</td>
</tr>
</tbody>
</table>

*Students that are studying IL2217 should not read this course*

**Supplementary information**

Degree project 30 credits advanced level is mandatory during the spring term.

Mandatory courses in one track can be selected as elective courses for the other tracks.

All elective courses in year 1 can also be studied in year 2.

**Year 3**
Appendix 2: Specialisations

Master's Programme, Embedded Systems, 120 credits (TEBSM), Programme syllabus for studies starting in autumn 2018

Track, International Dual Degree, Khalifa University (INDD)

Track, International Dual Degree, UESTC, China (INDK)

Track, Embedded Electronics (INEL)

Track, Embedded Software (INMV)

Track, Embedded Platforms (INPF)

Track, Embedded Control (INSR)