



Study Programme

Master's Programme, Embedded Systems, 120 credits

Masterprogram, inbyggda system

120.0 credits

Valid for students admitted to the education from Autumn 16 (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 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 informal 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-care) 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;

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.

Pre-requisites all line of studies: Computer Hardware 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), 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. 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.

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.

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 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 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

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.

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

Study enrolment is made before each term. 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. 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

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

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/en/regelverk/utbildning-forskning/grundutbildning/examensarbete/overgripande-rikt>

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 through the Personal menu at www.kth.se.

[Appendix 1 - Course list](#)

[Appendix 2 - Study programme descriptions](#)



Appendix 1: Course list

Master's Programme, Embedded Systems, 120 credits (TEBSM), Study programme for batch Autumn 16

Courses for All Specialisations

Year 1

Mandatory courses (7.5 cr.)

Course code	Course name	Credits	Edu. level
IL2206	Embedded Systems All Tracks	7.5	Second cycle

Recommended courses

Course code	Course name	Credits	Edu. level
IE1202	Analog Electronics Prerequisite for some courses in Embedded Platforms requiring Analog Electronics. N.B. The course is only given in Swedish.	7.5	First cycle

Year 2

Mandatory courses (22.5 cr.)

Course code	Course name	Credits	Edu. level
EH2760	Management of Projects	6.0	Second cycle
II2202	Research Methodology and Scientific Writing	7.5	Second cycle
MF2063	Embedded Systems Design Project	9.0	Second cycle

Supplementary information

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

Track, Embedded Electronics (INEL)

Year 1

Mandatory courses (37.5 cr.)

Course code	Course name	Credits	Edu. level
IL2302	Sensor Based Systems At least one of IL2302, IL2225 must be chosen.	7.5	Second cycle
IL2217	Digital Design with HDL	7.5	Second cycle
IL2225	Embedded Hardware Design in ASIC and FPGA At least one of IL2225, IL2302 must be chosen.	7.5	Second cycle
IL2237	Electronic Systems Design	7.5	Second cycle
IL2238	Fundamentals of Integrated Electronics	7.5	Second cycle

Conditionally Elective courses

Course code	Course name	Credits	Edu. level
DD2459	Software Reliability	7.5	Second cycle
EK2350	Microsystem Technology	7.5	Second cycle
ID2218	Design of Fault-tolerant Systems	7.5	Second cycle
IL2212	Embedded Software	7.5	Second cycle
IL2216	Media and Communication Electronics	7.5	Second cycle
IL2219	Radio Electronics	7.5	Second cycle
IL2220	Low Power Analogue and Mixed Signal ICs	7.5	Second cycle
IL2236	Embedded Many-Core Architectures	7.5	Second cycle
IL2450	System Level Validation	7.5	Second cycle
IS2202	Computer Systems Architecture	7.5	Second cycle

Recommended courses

Course code	Course name	Credits	Edu. level
EQ1220	Signal Theory Prerequisites for courses in Signal Processing	7.5	First cycle
EQ2310	Digital Communications	9.0	Second cycle

Year 2

Conditionally Elective courses

Course code	Course name	Credits	Edu. level
DD2425	Robotics and Autonomous Systems	9.0	Second cycle
EK2360	Hands-On Microelectromechanical Systems Engineering	7.5	Second cycle
EP2510	Advanced Networked Systems Security	7.5	Second cycle
II2300	Product Realization Processes I	7.5	Second cycle
IL2221	Advanced Topics in Mixed Mode Design	7.5	Second cycle
IL2452	System Design Languages	7.5	Second cycle
IS2500	RFID Systems	7.5	Second cycle

Track, Embedded Software (INMV)

Year 1

Mandatory courses (30.0 cr.)

Course code	Course name	Credits	Edu. level
DD2459	Software Reliability	7.5	Second cycle
ID2202	Compilers and Execution Environments	7.5	Second cycle
ID2207	Modern Methods in Software Engineering	7.5	Second cycle
IL2212	Embedded Software	7.5	Second cycle

Conditionally Elective courses

Course code	Course name	Credits	Edu. level
DD2427	Image Based Recognition and Classification	6.0	Second cycle
DD2431	Machine Learning	6.0	Second cycle
DT2140	Multimodal Interaction and Interfaces	7.5	Second cycle
EL2450	Hybrid and Embedded Control Systems Recommended prereq. EL1000	7.5	Second cycle
EP2500	Networked Systems Security	7.5	Second cycle
ID1217	Concurrent Programming	7.5	First cycle
ID2010	Programming of Interactive Systems	7.5	Second cycle

ID2201	Distributed Systems, Basic Course	7.5	Second cycle
ID2203	Distributed Systems, Advanced Course Requires ID2201	7.5	Second cycle
ID2204	Constraint Programming	7.5	Second cycle
ID2216	Developing Mobile Applications	7.5	Second cycle
ID2218	Design of Fault-tolerant Systems	7.5	Second cycle
IS2202	Computer Systems Architecture	7.5	Second cycle
MF2044	Embedded Systems for Mechatronics, II	6.0	Second cycle

Year 2

Conditionally Elective courses

Course code	Course name	Credits	Edu. level
DD2425	Robotics and Autonomous Systems	9.0	Second cycle
DT2140	Multimodal Interaction and Interfaces	7.5	Second cycle
EP2510	Advanced Networked Systems Security	7.5	Second cycle
ID1213	Logic Programming, Basic Course	7.5	First cycle
ID1217	Concurrent Programming	7.5	First cycle
ID2201	Distributed Systems, Basic Course	7.5	Second cycle
II2300	Product Realization Processes I	7.5	Second cycle
IL2217	Digital Design with HDL	7.5	Second cycle
IL2225	Embedded Hardware Design in ASIC and FPGA	7.5	Second cycle

Track, Embedded Platforms (INPF)

Year 1

Mandatory courses (30.0 cr.)

Course code	Course name	Credits	Edu. level
DD2459	Software Reliability	7.5	Second cycle
IL2217	Digital Design with HDL	7.5	Second cycle
IL2225	Embedded Hardware Design in ASIC and FPGA	7.5	Second cycle
IS2202	Computer Systems Architecture	7.5	Second cycle

Conditionally Elective courses

Course code	Course name	Credits	Edu. level
EK2350	Microsystem Technology	7.5	Second cycle
EL2450	Hybrid and Embedded Control Systems	7.5	Second cycle
EP2500	Networked Systems Security	7.5	Second cycle
EQ2300	Digital Signal Processing	7.5	Second cycle
EQ2310	Digital Communications	9.0	Second cycle
EQ2330	Image and Video Processing	7.5	Second cycle
ID2202	Compilers and Execution Environments	7.5	Second cycle
ID2218	Design of Fault-tolerant Systems	7.5	Second cycle
II2302	Sensor Based Systems	7.5	Second cycle
IL2212	Embedded Software	7.5	Second cycle
IL2219	Radio Electronics	7.5	Second cycle
IL2236	Embedded Many-Core Architectures	7.5	Second cycle
IL2237	Electronic Systems Design	7.5	Second cycle
IL2238	Fundamentals of Integrated Electronics	7.5	Second cycle
IL2450	System Level Validation	7.5	Second cycle
MF2044	Embedded Systems for Mechatronics, II	6.0	Second cycle

Recommended courses

Course code	Course name	Credits	Edu. level
EQ1220	Signal Theory	7.5	First cycle

Year 2

Conditionally Elective courses

Course code	Course name	Credits	Edu. level
DD2423	Image Analysis and Computer Vision	7.5	Second cycle
DD2425	Robotics and Autonomous Systems	9.0	Second cycle
DD2432	Artificial Neural Networks and Other Learning Systems	6.0	Second cycle
EK2360	Hands-On Microelectromechanical Systems Engineering	7.5	Second cycle
EP2510	Advanced Networked Systems Security	7.5	Second cycle
ID2201	Distributed Systems, Basic Course	7.5	Second cycle

ID2202	Compilers and Execution Environments	7.5	Second cycle
ID2207	Modern Methods in Software Engineering	7.5	Second cycle
II2300	Product Realization Processes I	7.5	Second cycle
IL2452	System Design Languages	7.5	Second cycle
IS2500	RFID Systems	7.5	Second cycle

Track, Embedded Control (INSR)

Year 1

Mandatory courses (36.0 cr.)

Course code	Course name	Credits	Edu. level
DD2459	Software Reliability	7.5	Second cycle
EL2320	Applied Estimation At least one of EL2320, EL2620 must be chosen.	7.5	Second cycle
EL2450	Hybrid and Embedded Control Systems	7.5	Second cycle
EL2620	Nonlinear Control At least one of EL2620, EL2320 must be chosen.	7.5	Second cycle
MF2030	Mechatronics basic Course	6.0	Second cycle

Conditionally Elective courses

Course code	Course name	Credits	Edu. level
DD2427	Image Based Recognition and Classification	6.0	Second cycle
DD2431	Machine Learning	6.0	Second cycle
EK2350	Microsystem Technology	7.5	Second cycle
EL2520	Control Theory and Practice, Advanced Course	7.5	Second cycle
EL2820	Modelling of Dynamical Systems	7.5	Second cycle
ID2218	Design of Fault-tolerant Systems	7.5	Second cycle
II2302	Sensor Based Systems	7.5	Second cycle
IL2212	Embedded Software	7.5	Second cycle
MF2007	Dynamics and Motion Control	9.0	Second cycle
MF2043	Robust Mechatronics	6.0	Second cycle
MF2044	Embedded Systems for Mechatronics, II	6.0	Second cycle

Recommended courses

Course code	Course name	Credits	Edu. level
EL1000	Automatic Control, General Course Prerequisite for advanced courses in Automatic Control	6.0	First cycle

Year 2

Conditionally Elective courses

Course code	Course name	Credits	Edu. level
DD2423	Image Analysis and Computer Vision	7.5	Second cycle
DD2425	Robotics and Autonomous Systems	9.0	Second cycle
DD2432	Artificial Neural Networks and Other Learning Systems	6.0	Second cycle
EK2360	Hands-On Microelectromechanical Systems Engineering	7.5	Second cycle
EL2620	Nonlinear Control	7.5	Second cycle
EQ2320	Speech Signal Processing	6.0	Second cycle
EQ2340	Pattern Recognition	7.5	Second cycle
II2300	Product Realization Processes I	7.5	Second cycle
IL2217	Digital Design with HDL	7.5	Second cycle
IL2225	Embedded Hardware Design in ASIC and FPGA	7.5	Second cycle

Year 3



Appendix 2: Specialisations

Master's Programme, Embedded Systems, 120 credits (TEBSM), Study programme for batch Autumn 16

Track, Embedded Electronics (INEL)

Track, Embedded Software (INMV)

Track, Embedded Platforms (INPF)

Track, Embedded Control (INSR)
