Study programme: Embedded systems

Objectives

About 99 percent of all computers today are embedded – they are found in cell phones, game consoles, digital cameras, cars, airplanes, medical equipment, home appliances, robots, etcetera. The market for embedded systems is enormous, and the industry's demand for high-skilled experts in these areas is constantly increasing.

We offer a top-quality education in embedded systems, with world-known expert teachers, industrial student projects, and closely related to our world-known research in the area. Embedded Systems is the most intensive research area at Mälardalen University and it is among top-five research centers in the world in embedded systems.

Upon successful completion, our students will be highly competitive on the national and international job market, both in the industry as high-skilled expert and in the academia as a researcher or prospective PhD student. After studies, the students will be able to make a career as e.g., engineers, project leaders, system architects, programmers or researchers in the fields of e.g., automotive industry, robotics, telecom, industrial process control, consumer electronic, etc.

Knowledge and Understanding

After completion of this course block the student will show:

- knowledge and understanding of fundamental embedded systems design paradigms, architectures, possibilities and challenges, both with respect to software and hardware,
• a wide competence from different areas of technology, especially from computer engineering, robotics, electronics, intelligent systems and mechatronics.
• deep state-of-the-art theoretical knowledge in the areas of real-time systems, artificial intelligence, learning systems, sensor and measuring systems, and their interdisciplinary nature needed for integrated hardware/software development of embedded systems.
• ability to analyze a system both as whole and in the included parts, to understand how these parts interact in the functionality and properties of the system, and
• understanding and experience of state-of-the-practice industrial embedded systems and intelligent embedded system development.

Aptitudes and Accomplishments
After completion of this course block the student will be able to:
• practically apply gained theoretical knowledge in order to design, analyze and implement embedded systems, e.g. integrating embedded subsystems and applications in building a fully functional autonomous robot.
• apply formal method, testing, verification, validation and simulation techniques and tools in order to engineer reliable and safe embedded systems,
• demonstrate a deeper understanding of the electronics and physical principles used for embedded biomedical measuring systems
• communicate their knowledge to engineers and non-engineers, both orally and in writing, and
• interact effectively in system development teams involving people from different cultures and backgrounds.

Ability to Evaluate and Assess
After completion of this block the student will:
• be able to locate, read, understand and review research papers, and hence be familiar with the state-of-the-art in embedded systems,
• be able to choose appropriate methodological and analytical tools to analyze and interpret research results both quantitatively and qualitatively, and
• have skills such as self-reflection, critical reasoning and the ability to manage complex problems.

Language
The block is taught solely in English.

Special Eligibility Requirements
Completed Bachelor’s degree (or equivalent) of 3 years (180 ECTS credits) or more, in an engineering subject or computer science, of which at least one semester (30 ECTS credits) in computer engineering, computer science or electronics that include courses in programming corresponding 15 ECTS credits. At least 22.5 ECTS credits in Mathematics/Applied Mathematics are required. English B is required for Swedish students. Foreign students are required to submit a TOEFL test result, minimum score 550 with a TWE score of at least 4 (PBT) or 79 with a TWE score of at least 17 (iBT) or an IELTS test result with an overall band score of minimum 6.0 and no band score below 5.0 or equivalent.

Selection
Selection is based on the number of academic credits.

Contents

The course block consists of a project related part and a theoretical coursework part. Several projects are supplied by our industrial partners, and are solved in collaboration with them. The aim with sharp industrial projects is to prepare students for work in industry directly after the completion of their education, and to make our students are highly competitive on the national and international job market.

The course part provides adequate theoretical knowledge to solve the problems that the students are faced to. It consists of three areas:

1) Methodology – provides necessary methods and tools for successful project management.
2) Embedded Systems – provides knowledge about development of safety-critical, real-time applications for small and distributed embedded devices. It also covers hardware for embedded systems, energy efficiency, testing and debugging, communication, etc.
3) Intelligent systems – provides knowledge about learning systems, advanced sensor and measurement systems, in the context of embedded applications and medical devices.
The table below gives an overview of the individual course units per study semester.

<table>
<thead>
<tr>
<th>Semester 1 (Fall)</th>
<th>Semester 2 (Spring)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVA317 – Project methodology, 7.5 ECTS cred.</td>
<td>DVA406 – Intelligent systems, 7.5</td>
</tr>
<tr>
<td>DVA316 – Embedded Systems I, 7.5</td>
<td>ELA402 – Biomedical engineering, 7.5</td>
</tr>
<tr>
<td>DVA404 – Embedded Systems II, 7.5</td>
<td>DVA409 – Project in intelligent embedded systems, 15</td>
</tr>
<tr>
<td>DVA408 – Project in Embedded Systems, 7.5</td>
<td></td>
</tr>
</tbody>
</table>

The details about the courses can be found in their syllabuses at:

http://www.mdh.se/studieinformation/kursplaner.jsp

**Choices within the block**

The student will be given a possibility to choose between several different projects within the project courses.

**Host School**

School of Innovation, Design and Engineering

**Quality Assurance**

The program is continuously evaluated by the steering committee that consists of the representatives from the academia, students, and industrial partners. The School of Innovation, Design and Engineering (IDT) is responsible for the planning of the program, for the dissemination of information about the program, for guiding its students, and for an on-going evaluation of the program. Evaluation of courses plays an important part in periodic revisions of the program.

**Research Base**

Embedded systems is the most research-intensive research area in Mälardalen University and consists of two research profiles: Mälardalen Real-Time research Centre (MRTC) and Intelligent Sensor Systems (ISS). MRTC is a national leader in Embedded Systems research. Research at MRTC has a dominating focus on Embedded Software, with a mission is to provide research excellence that enable industry to take advantage of the
opportunity provided by software in products and production systems. Within the ISS profile, research is multidisciplinary and spans over areas such as Biomedical Engineering, Artificial Intelligence, Robotics, Computer Communication and Electronic Circuit Design. The research is applied, focusing towards mobile, intelligent sensor systems leading to increased safety and effectiveness within industry, care, healthcare and sports medicine. Both MRTC and ISS are involved in delivering of this course block. Hence, the courses will be given by active researchers in the field, and they will contain state-of-the-art research results.

**Industrial Cooperation**

Our ambition is to be in the middle of reality. Therefore our activities in education and research are performed in close cooperation and co-production with industry, organizations and public communities both locally, regionally, nationally and internationally. This course block is supported by several industrial partners, most of them actively involved in the education through industrial projects for students, mentorship and guest lectures. We use our industrial partners to assure the quality and industrial relevance of our educational programs. They provide us sharp industrial equipment, give guest lectures at our courses, organize industrial visits, provide internships and theses for our students, and, whenever possible, give employment to our students.

**Equality and equal opportunities**

Mälardalen University has established bodies and procedures that deal with equal opportunities, gender balance, and social equity. We have norms and routines for ensuring fair selection and provide specific support for different groups related to equality or additional support for the needed groups. Computer engineering is an area in which traditionally female students are less participating than male students. For this reason we will increase efforts to attract more female students.

Furthermore, MDH is equipped to accommodate students with various disabilities. Disabled students have their own service, which can help in arranging any extra equipment necessary to make their stay as convenient as possible. For example, there is special equipment for students with reduced sight and hearing. The universities has also specialized support for students with dyslexia and are equipped to accommodate students with various other disabilities. A common factor of most of our buildings is that they are either new or have been painstakingly renovated to provide support for disabled students.