R&D Experience (B-KUL-T47UXW)

9 ECTS | English | 92 | First term | Cannot be taken as part of an examination contract

Vanden Abeele Vero (coordinator) | More
OC Elektronica-ICT - Campus Groep T Leuven

Aims

The objective of the OPO R&D Experience is to provide students with an authentic Research & Development experience. First, students are introduced to basic knowledge pertaining to one of the options below. Next, students are expected to acquire knowledge by themselves on the state-of-the-art and advance their knowledge on the chosen research specializations independently. Moreover, students are expected to apply this knowledge to a real-world challenge. To do so, students will work with real stakeholders or on academic research challenges. Students will work on this challenge in teams, during the entire semester, needing both project management and communication skills.

Students can choose from one of the 4 options below:

Option 1. Signal Processing Algorithms and Implementations: Students learn how to design and implement state-of-the-art algorithms for digital signal processing (DSP) applications in audio, speech, image, communications, and biomedical technology. Their design and implementation skills will be fostered by acquiring a profound understanding of the basics of statistical signal processing and by being introduced to timely DSP research topics presented by guest lecturers from academia and industry. These skills will then be further developed in hands-on DSP hardware implementation sessions and will be exploited by participating in an international student R&D competition.

Option 2. Embedded systems: Students learn how to create an embedded system environment for playing retro video games. The development of the gaming environment covers aspects related to sensor/controller interfacing, video display generation, digital control systems and real time processing. The system is built on a modern System-on-Chip (SoC) containing an embedded processor with reconfigurable FPGA logic. Students will learn how to program and partition the hardware/software design space, deciding which parts of the project are implemented on fast, custom-made hardware logic and which parts run on the more flexible processor. The end goal of the project is to develop a classic retro game that runs in real time on the embedded platform.

Option 3. Games & Tangibles: Students learn how to design, build and reflect on a game using rich tangible interaction for player input and/or output. Possible technologies included in this course are game engines such as Unity, and sensing technologies like motion sensors, 3D cameras, or smart objects. Additionally, students are introduced to the theory of game design, development, and evaluation in a player-centric design context. Particular emphasis is also put on interaction design, and theories and methodologies relevant to tangible interaction. Students are expected to apply these technologies and methods in a research project in which they design, implement and evaluate a game with tangible player input and output. Depending on the quality of the resulting systems, results will be exploited through system demonstrations at academic conferences, or participation in international academic game design competitions.

Option 4. UX Driven Web Development: Students learn how to build an n-tier web application, providing a rich user experience. Technologies introduced and discussed are: HTML, CSS, JavaScript, PHP, PHP-ORM, PHP-Framework, JavaScript Applications, Mashups, advanced database technologies, XML, web services, etc. In addition, students are introduced to human-computer interaction and how to apply a user-centered design process. Ultimately, these technologies and methods are applied by the students in a full-blown application, validated by an external client or participation in an international academic environment.

Learning outcomes

- MK1: Scientific-disciplinary knowledge and comprehension in the field of Engineering Technology
- MI1: Problem analysis and solving
- MI2: Design and / or development
- MI4: Ethical behavior
- MG1: Information gathering and processing
- MG2: Communication with engineers and non-engineers
- MG3: Critical thinking
- MG4: Working in a team in different roles
- MG5: Professionalism

Explanation

- to master specialized skills in one of the above domains (MK1);
- to develop for an external client/authority (MI4, MG2, MG5);
- to work in team following a process management technique (MG2, MG3, MG4);
- to read and process state-of-the-art information (available in research articles or technical forums) and apply this independently (MK1, MI1);
- to solve open problems: analyse the problem, think about alternative solutions and come to a well-founded solution (MI1);
- to think creatively, to solve a problem and add more value to the application (MI2);
- to select the most appropriate technology and to justify his/her choice (MK1, MG1, MG3);
- to know about standards and best industry practices and to be able to develop conform this standards and practices(MK1, MG1).

Order of Enrolment

Mixed prerequisite:
You may only take this course if you comply with the prerequisites. Prerequisites can be strict or flexible, or can imply simultaneity. A degree level can be also be a prerequisite.
Explanation:
STRICT: You may only take this course if you have passed or applied tolerance for the courses for which this condition is set.

FLEXIBLE: You may only take this course if you have previously taken the courses for which this condition is set.
SIMULTANEOUS: You may only take this course if you also take the courses for which this condition is set (or have taken them previously).
DEGREE: You may only take this course if you have obtained this degree level.

(SIMULTANEOUS(T34EE5)) OR (STRICT(T2EE4A) AND FLEXIBLE(T1AWS0))

The codes of the course units mentioned above correspond to the following course descriptions:
T1AWS0 : Aanvullingen uit de wiskunde (No longer offered this academic year)
T2EE4A : Engineering Experience 4 - Electronics Engineering
T34EE5 : Engineering Experience 5 - Electronics Engineering

Is included in these courses of study

Master in de industriële wetenschappen: elektronica-ICT (Leuven) 60 ects.
Master of Electronics and ICT Engineering Technology (Leuven) 60 ects.

Activities

2.5 ects. **R&D Experience: Lectures** (B-KUL-47hUXW)

2.5 ECTS English **Format: Lecture** **20** **First term**

Gerling Kathrin | **Geurts Luc** | **Vanden Abeele Vero** | **van Waterschoot Toon** | **Balasch Masoliver Josep** (cooperator)

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Content

The content of the lectures depends on the option chosen by the student and is listed below.

Option 1. Signal Processing Algorithms and Implementations: After a brief review of digital signal processing (DSP) basics and an introduction to current DSP research and applications, we will start exploring the exciting area of statistical signal processing. We will first acquire basic insight into information theory, and cover some simple statistical methods, e.g., for noise modeling and time delay estimation. We will then continue with an in-depth treatment of four topics: least-squares estimation, optimal filtering, adaptive filtering, and linear prediction. Throughout the lectures, we will learn about direct applications of the theory in audio, speech, image, communications, and biomedical signal processing.

Option 2. Embedded systems: During the lectures the students are introduced into the theory and design methodology regarding embedded systems. First, the students are taught the fundamentals of register transfer level abstraction, together with making testbenches for the RTL they design. Then, this is applied to modern FPGA SoC, where programmable logic exists together with a processor core. Also high level synthesis is explored and its application to digital signal processing. Finally, embedded operating systems are discussed together with the implementation of hardware to software connection, using device drivers.

Option 3. Games & Tangibles: The lectures introduce students to theoretical perspectives on (digital) games and play, addressing issues around their aesthetics and the mechanics that govern play, and theories and frameworks for tangible interaction. Here, students are guided through rapid prototyping strategies for player-computer interaction, and introduced to the basics of game design. Students are further introduced to programming paradigms for games and interactive systems, and introduced to technologies for tangible interaction, ranging from commercially available systems to research prototypes. Finally, lectures address playtesting and user studies as means of evaluating performance of and experience provided by playful interactive systems.

Option 4. Lectures UX Driven Web Development: Students are introduced to theories and methods regarding designing user interfaces, tailored to human characteristics and embedded in social practices. Therefore, students are taught the foundations of the discipline of human-computer interaction. Students know the basic theories, laws, and models that form the basis of human computer interaction. They get to know important interaction paradigms, interaction styles, and interactive devices and can situate these in the history of human-computer interaction. Students are introduced to the basics of ergonomics, cognitive psychology, social sciences and design sciences and their relevance towards human-computer interaction.

Course material

Available on TOLEDO:

- Personal notes
- Slides and handouts of of the lectures, guest lectures and seminars
- Selected websites and videos
- Research articles

Format: more information

- Lectures
- Seminars
- Guest lectures

6.5 ects. **R&D Experience: Project** (B-KUL-47IUXW)

6.5 ECTS English **Format: Assignment** 72 **First term**

More

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Content

The content of the project depends on the option chosen by the student and is listed below.

Option 1: Signal Processing Algorithms and Implementations: In this project, students will be coached to apply their insights and understanding of DSP theory to hands-on R&D and implementation tasks. Three types of activities will be organized. Firstly, guest lecturers from academia and industry will introduce the students to state-of-the-art DSP applications in a research seminar series. Secondly, during hands-on lab sessions, the students will learn how to implement a DSP algorithm in hardware and will immediately apply these skills to a small-scale implementation project on the TI C5515 eZDSP platform. Thirdly, throughout the semester, groups of 5-10 students will work autonomously on a student research challenge organized by the IEEE Signal Processing Society.

Option 2: Embedded systems: In this project, the students work in small groups to build a retro video gaming environment on the Xilinx Zynq system. In the first stage, the components of the gaming environment (gamepad controller, graphic display) will be interfaced to the SoC. In a second stage, these components will be integrated in a starting application where graphic animations are controlled using the gamepad. In the third and last stage, students will choose a retro game to implement. Once the game logic and functionality is clearly specified, they will develop the necessary hardware and software components using the possibilities of the SoC. It is also possible to incorporate different input gaming devices (e.g. joystick). The end goal of the project is to obtain a fully-functional retro game that runs on the SoC platform in real time.

Option 3: Games & Tangibles: Students will work in teams of four to develop a focused gaming experience controlled via a tangible input device, with design and development focus echoing the lecture areas of game design, game development, player experience, and theory and practice of tangible interaction. The game will be implemented in Unity (scripting in C# or JavaScript) in combination with sensor technology made available to the students (e.g. Kinect, motion sensors, intelligent materials). They are expected to design and implement basic game logic, and develop and/or integrate a tangible game controller. Here, special attention needs to be paid to the affordances of the game and the implications for the choice of input device (and vice versa) along with player experience outcomes. Focus of the project is on the development of a functional prototype that can be explored by players.

Option 4: Project UX Driven Web Development: In this project, a full blown web application is developed in team. Students may cooperate with/work for an external client who will provide feedback at different moments during the semester and validate the final outcome, or work in the context of an academic research challenge. During the project's hands-on sessions students (attendance is obliged) students are introduced to different technologies. These are, among others, HTML, CSS, JavaScript, PHP, PHP-ORM, PHP-Frameworks, JavaScript Applications, Mashups, advanced database technologies, XML, web services, ... Later on, these need to be applied by the students themselves in the final application. Students are also invited to be creative and to move beyond the basic technologies and look for additional state-of-the-art frameworks, libraries, patterns as this field is characterized by a rapid evolution. Moreover, as web applications are characterized by high interaction with end users, students need to apply a user-centered design process and use SCRUM (or a SCRUM-alike process) as an Agile project management framework.

Course material

- Slides, exercise files and handouts of of the hands-on sessions, guest lectures and seminars
- Selected articles, websites and videos

Format: more information

- Combination of hands-on sessions, guest seminars and design/development/programming sessions. Attendance is mandatory.

Evaluation

Evaluation: R&D Experience (B-KUL-T72019)

Type : Partial or continuous assessment with (final) exam during the examination period

Explanation

1. Realisation of the final mark

The final mark for R&D Experience is a whole number between 0 and 20. The final mark of this course is calculated based on the published component marks with the following weighting factors:

- R&D Experience Lectures : 30%
- R&D Experience Project : 70%

The only exception to this rule is described in the complementary regulation of the Faculty of Engineering Technology to article 66 in the Regulations on Education and Examinations.

2. Realisation of published partial figures

The component mark for 'R&D Experience Lectures' is a whole number between 0 and 20.

- This evaluation can take the shape of either a (group) paper, an oral exam, a written examination, or a combination of the former. In any case, for each of these different examination forms, students need to process and study the course material of the lectures. The specific details are communicated via Toledo.

The component mark for 'R&D Experience Project' is a whole number between 0 and 20.

- At the end of the course, students, in team, need to present and defend their work. While not every student will have contributed to every part of the project's result, every student should have at least a basic knowledge of all the technologies used and should be able to answer questions related to this. Depending on the team's realizations and on the individual answers students provide during the defense, individual scores are given. In addition, a student's contribution to the team might be poor or outstanding. Therefore, there will be a peer assessment that yields an additional bonus or a malus of +3 to -3. Moreover, the evaluation of intermediate project reporting during the semester will also contribute to the individual scores.

3. Absences

- Unauthorized absence during the exam leads to NA as a component mark for 'R&D Experience: Lectures'.
- Unauthorized absence during one or more project sessions lead to NA as a component mark for 'R&D Experience: Project'.

For absences during the teaching weeks, please contact the education ombuds on the first day of your absence. If you missed one or more obligatory sessions, please contact your professor as soon as possible and certainly within a week. For absences within the exam period, please contact the exam ombuds on the first day of your absence.

Information about retaking exams

This course unit allows partial mark transfers in case of partial pass mark:

- 47hUXW - R&D Experience: Lectures (during and beyond academic year)
- 47lUXW - R&D Experience: Project (during and beyond academic year)

- R&D Experience Lectures.
  - The student has to redo the (group) paper, oral or written exam.
- R&D Experience project :
  - The student has to work on a small project, using similar technologies/methods/algorithms as for the team's project, but this time not in a team but on his/her own. For specific details the student should contact the course coordinator.

Required in stage	Optional in stage	First term	Second term	Both terms
This year	Next year	Alternating years	External	Prerequisites
Taught by	Language of instruction	Duration		

ADMISSIONS

- How to apply
- Scholarships
- Degree-seeking students
- Non-degree-seeking students
- Doctoral students
- Reseachers
- Short-term study visits
- Prepare your stay

QUICKLINKS

- Alumni
- International Office
- Student Services
- Pangaea
- LRD
- UZ Leuven
- Jobs and Careers
- Libraries
- News and press
- Agenda
- Culture
- Sports
- KU Leuven shop
- Contact

INTERNAL TOOLS

- Toledo
- KU Loket
- Webmail
- Intranet
- Who's who
- Organisational chart

OTHER LANGUAGES

- Nederlands
- Français
- Deutsch
- Español
- 中文版
- Русский

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