Name Module	Cyber-Physical Systems
Language	English
Contact person	Boudewijn Haverkort
Specific prerequisites (regarding incoming exchange)	
Participating study	TI, EE
Starting block	Year 3, block 2 (2015-2016)

Theme

Embedded systems together with their physical environment are called cyber-physical systems (CPS). Examples include power grids, transportation systems, integrated car-to-car communication systems, robotics systems, or integrated satellite computing and communicating equipment. CPS must be highly dependable, (energy-) efficient and meet real-time constraints and require customised user interfaces.

This module will provide an introduction cyber-physical systems design, the required specification models and language, and will address a number of application-areas for CPS. Specialised hardware devices, the essentials of real-time operating systems, and essentials of control systems are also presented.

Content (including project)

The 10-week block will consist of two phases. Phase 1 will be a regular lecturing phase, whereas Phase 2 is the project phase, as follows.

In Phase 1 (5 to 6 weeks), students will follow courses, tutorials and small labs in the following topics:
1a) formal specification and hybrid systems;
1b) dependable system and network design and evaluation;
1c) sensor and actuator systems;
1d) embedded hardware design;
1e) control systems engineering.
It might be that one or more of these 'mini-tracks" are optional or tailored specifically for one or another group of students. As an example, most probably EE students will not have to enrol in the control systems engineering mini-track.

In Phase 2 (3 to 4 weeks), we plan project work (in small teams) in which the material from the Phase 1 will be put to practice in small projects. Result of such a project will be a short research paper (say, up to 6 pages, IEEE double column format). Note that the above "put to practice" can mean that students indeed do practical experiments or extended lab work, but might also be of a more theoretical nature. We plan to propose projects to students in a ore application-oriented way, along the lines of, for instance, car-to-car communications, precision machine control, smart grids, healthcare robotics, data centres, or (satellite) communication systems.

In the last week of the term (week 10) there will be exams and "repair facilities".

Learning goals

To be further developed.

Educational forms

In Phase 1 we envisage to have 4 to 5 parallel mini-tracks (each on a specific day of the week) that all combine (to the taste of the mini track-coordinator) classical lectures, tutorials and lab work.
Phase 2 will be project work, in small groups, with an individual assessment based on a research paper and a presentation. Phase 2 might be finished with a "workshop" in which all student projects are presented.

Assessments

There will be, for each mini-track, a final assessment (written or oral); each mini-track can also dedicate part of the grade to homework assignments of small lab work. The grades for the mini-tracks as well as the grad for the project will be averaged and combined (in a weighted fashion) with the project work grade.

Involved groups

This module will be further developed by a number of groups from EEMCS, in particular:

- DACS (Haverkort)
- PS (Havinga)
- CAES (Smit)
- FMT (Langerak)
- RAM (Broenink)