The goal of this course is to transmit knowledge in sensing, computing, communicating, and actuating for programmable field instruments and, more generally, embedded systems. The student will be able to put in practice the knowledge acquired using concrete software and hardware tools.

Content

- Introduction to the C language and the UNIX environment
- Hardware resource constraints and their impact on C programming
- Basic signal processing techniques
- Dynamical systems without and with feedback, open-loop and closed-loop control
- Basic linear control techniques
- Basic communication techniques
- Microcontrollers, sensors, actuators, and transceivers
- Hardware choices and resource management
- Examples of programmable, mobile field instruments

Keywords

Signal processing, programming, control, communication, embedded systems, mobile robotics, sensors, field instruments

Learning Prerequisites

Required courses
Analysis I to IV (complex analysis), fundamentals in C and Matlab programming

Recommended courses
Fundamental in probability and statistics, fundamental in control and dynamical systems

Learning Outcomes

By the end of the course, the student must be able to:
• Estimate environmental monitoring system requirements (communication, sensing, actuation, computation)
• Develop software for an embedded system/instrument
• Analyze signals in time and frequency domain
• Analyze C program outputs
• Implement C code
• Compute direct and inverse Fourier Transforms
• Analyze constraints and resources of an embedded system/instrument
• Conduct systematic experiments and system performance evaluation
• Design (digital) filters
• Design control algorithms
• Estimate environmental monitoring system requirements (communication, sensing, actuation, computation)
• Develop C software for embedded systems
• Analyze signals in time and frequency domain
• Compute direct and inverse Fourier Transforms
• Analyze constraints and resources of an embedded system/instrument
• Conduct system performance evaluation
• Design digital filters
• Design control algorithms

Transversal skills
• Plan and carry out activities in a way which makes optimal use of available time and other resources.
• Write a scientific or technical report.
• Demonstrate a capacity for creativity.
• Access and evaluate appropriate sources of information.
• Make an oral presentation.
• Collect data.
• Evaluate one's own performance in the team, receive and respond appropriately to feedback.

Teaching methods
Ex-cathedra lectures, assisted exercises with mid-term verification, and a course project involving teamwork

Expected student activities
Attending lectures, carrying out exercises and the course project, and reading handouts.

Assessment methods
Written exam (50%) with continuous control during the semester (50%).

Supervision
Office hours	Yes
Assistants	Yes

Resources
Bibliography
Lecture notes, a few targeted papers/book chapters

Websites
• http://disal.epfl.ch/teaching/signals_instruments_systems

Moodle Link
• https://moodle.epfl.ch/course/view.php?id=7321

Prerequisite for
Distributed Intelligent Systems (M1 and M3)