Front-End instrumentation

Component
École Nationale Supérieure d'Électrotechnique d'Électronique d'Informatique d'Hydraulique et des Télécommunications

In brief

> **Ametys Code:** N8AE12B

> **Open to exchange students:** No

Presentation

Objectives

By the end of this course, students will be able to:

• Understand the fundamental principles of analog-to-digital (ADC) and digital-to-analog (DAC) conversions.

• Analyze sources of noise and error in instrumentation chains, including quantization noise and spectral aliasing.

• Design and size appropriate anti-aliasing filters, particularly using switched-capacitor filters.

• Select and configure components (ADCs, DACs, filters) based on application requirements.

• Evaluate the performance of signal acquisition or generation chains.

Description

This course covers the principles and challenges of signal conversion and processing in instrumentation chains. Key topics include:

- Analog-to-Digital (ADC) and Digital-to-Analog (DAC) Conversion: Architectures (flash, SAR, sigma-delta, etc.), resolution, speed, and limitations.

- Noise and Errors: Quantization noise, signal-to-noise ratio (SNR), total harmonic distortion (THD), and spectral aliasing.

- Associated Filtering: Design of anti-aliasing filters, switched-capacitor filters, and digital filters (FIR, IIR).

- Practical Applications: Case studies on acquisition chains (sensors, conditioning, ADC) and signal generation (DAC, reconstruction, filtering).

- Tools and Methods: Use of simulation software (PSpice, MATLAB) and measurement instruments (oscilloscope, spectrum analyzer).

The course combines theoretical lectures, tutorials, and lab sessions to apply concepts to real-world problems.

Pre-requisites

- Basic knowledge of analog electronics (operational amplifiers, passive and active filters).

- Familiarity with signal processing concepts (Fourier transform, sampling).

- Experience with simulation software (PSpice, MATLAB).

- Basic knowledge in FPGA programming (VHDL, Vivado)