

Front-End instrumentation



Component

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

In brief

- > **Ametys Code:** N7EE08B
- > **Open to exchange students:** Yes

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)