

Course guide

330805 - II - Industrial Instrumentation

Last modified: 07/07/2026

Unit in charge:	Manresa School of Engineering	
Teaching unit:	750 - EMIT - Department of Mining, Industrial and ICT Engineering. 709 - DEE - Department of Electrical Engineering.	
Degree:	MASTER'S DEGREE IN INDUSTRIAL FACILITY DESIGN AND MANAGEMENT (Syllabus 2026). (Compulsory subject).	
Academic year: 2026	ECTS Credits: 5.0	Languages: Catalan

LECTURER

Coordinating lecturer: Ribas Fargas, David

Others: Ribas Fargas, David

PRIOR SKILLS

The course is accessible and only requires elementary notions of electrical circuits (such as Ohm's law and the distinction between voltage and current). Students only need basic logical thinking to interpret data and a curious attitude toward component assembly and the digital environment.

REQUIREMENTS

No prerequisite courses or prior knowledge of advanced programming or complex electronics are required. All content regarding sensors, signal processing, and digital integration will be explained from scratch in a guided manner.

TEACHING METHODOLOGY

The following learning strategies will be combined:

Theoretical classes: Dynamic sessions presenting sensor selection criteria and protocols (such as IO-Link) based on real-world industrial plant cases.

Practical classes: Laboratory workshops where students will learn to wire 4-20 mA loops, diagnose faults using instrumentation, and apply digital data filters.

Course project: Teamwork to design a real measurement chain, connecting physical sensors to a SCADA interface with alarms and cloud connectivity.

LEARNING OBJECTIVES OF THE SUBJECT

[M3.K2 - Knowledge]: Describe the operation of measuring instruments useful for industrial automation and system status monitoring.

- Selection and installation of instrumentation: Learn to choose and connect mechanical, thermal, and electrical sensors in industrial environments. Voltage signals and 4-20 mA current loops will be mastered from scratch.

- Digital integration and communications: Acquire the ability to integrate the measurement chain with PLCs, IO-Link protocols, and cloud IoT platforms. The entire process will be guided and will not require advanced programming.

[M3.S2 - Skills]: Determine the instrumentation needs of an industrial facility to diagnose and predict the system status.

- Data processing and quality: Apply simple discrete filtering algorithms (moving averages, interpolations, and outlier removal) to clean the signal. This will allow for the correct analysis of process behavior and stability.

- Industrial supervision and diagnostics: Design SCADA screens by configuring alarms and setpoints for plant monitoring. Learning will be oriented towards fault diagnosis and the basics of predictive maintenance.



STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	100.00

Total learning time: 45 h

CONTENTS

Industrial instrumentation

Description:

Industrial instrumentation, from the physical sensor to digital control, connects the real world with automation and masters the entire measurement chain. This course will enable students to select, install, and maintain the appropriate instrumentation for any industrial environment. From the fundamentals of metrology and the 4-20 mA loop to integration with PLCs, IO-Link, and IoT systems. The course will have a practical approach focused on fault diagnosis, data quality, and predictive maintenance in Industry 4.0.

COURSE CONTENTS

Module 1: Fundamentals of Instrumentation

- 1.1. Structure of measurement systems
- 1.2. Process variables and units
- 1.3. Static characteristics of sensors
- 1.4. Static sensor errors
- 1.5. Dynamic sensor errors

Module 2: Industrial Communications

- 2.1. Basic concepts and voltage signals
- 2.2. The 4-20 mA current loop
- 2.3. Digital communications and IO-Link
- 2.4. Integration: From PLC to Cloud
- 2.5. Practical block (Lab sessions)

Module 3: Signal Processing

- 3.1. Moving Average
- 3.2. Moving Median
- 3.3. Extremes analysis
- 3.4. Change analysis
- 3.5. Outlier detection and removal
- 3.6. Interpolation
- 3.7. Stability measurement

Module 4: Practical Project on Industrial Sensors

- 4.1. Mechanical, thermal, process, and electrical sensors
- 4.2. Connection, signal processing, SCADA systems programming, alarms, and setpoints

Module 5: Safety in Industrial Systems

- 5.1. Safety layers in industrial environments
- 5.2. Redundancy

Module 6: Sensors for electrical installations

Module 7: Smart instrumentation

Specific objectives:

Design and wire 4-20 mA current loops and both analog and digital sensor connections (IO-Link) in industrial environments.
Implement discrete filtering algorithms to clean signals and evaluate process stability.
Configure SCADA screens with alarms and setpoints for real-time monitoring and fault diagnosis.
Apply condition-based predictive maintenance techniques (such as vibration analysis and thermography).

Related activities:

Problem sets for each module.

Lab 1: Digital integration: from sensor to PLC and cloud.

Lab 2: Connection, data acquisition, and monitoring of a level sensor.

Project: Connection, acquisition, and design of a SCADA system with alarms and setpoints for an industrial sensor.

Full-or-part-time: 90h

Theory classes: 40h

Guided activities: 10h

Self study : 40h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the [Action Framework for Academic Integrity in Assessment at the UPC](#).

Assessment of activities and projects (40%): Continuous work will be rewarded through the grade of the practical integrative project (20%) and the laboratory reports (20%).

2 Midterm exams (30% + 30%): Conceptual test focused on practical problem-solving and industrial equipment selection. A minimum grade of 3.5 is required to pass the course.

EXAMINATION RULES.

The center's code of best practices will be applied for the supervision of gradable activities and exams, ensuring original authorship and the regulation of the use of artificial intelligence.

BIBLIOGRAPHY

Basic:

- Bentley, John P. Principles of measurement systems. 4th ed. New York: Pearson Prentice Hall, cop. 2005. ISBN 9780130430281.
- Creus Solé, Antonio. Instrumentación industrial [on line]. 8a ed. Barcelona: Marcombo, 2011 [Consultation: 11/06/2026]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=9767. ISBN 9788426716682.
- Terry L.M. Bartelt. Industrial automated systems: instrumentation and motion control. 1a. Cengage Learning, 2010. ISBN 9781435488885.
- Morris, Alan S; Langari, Reza. Measurement and instrumentation: theory and application [on line]. Waltham, MA: Academic Press, 2012 [Consultation: 11/06/2026]. Available on: <https://www-sciencedirect-com.recursos.biblioteca.upc.edu/book/monograph/9780123819604/measurement-and-instrumentation>. ISBN 0-12-381962-8.