Fakultät für Ingenieurwesen
Facoltà di Ingegneria
Faculty of Engineering

COURSE DESCRIPTION – ACADEMIC YEAR 2024/2025

Course title	**Programmable Controllers for Industrial Automation**
Course code	42168
Scientific sector	IIND-08/A
Degree	Bachelor Industrial and Mechanical Engineering (L-9)
Semester	2nd
Year	III
Credits	6
Modular	No

Total lecturing hours	36
Total laboratory hours	24
Attendance	Attendance to lecture hours is not mandatory. Attendance to laboratory hours is also not mandatory but is strongly recommended (see Assessment section).
Prerequisites	
Course page	Microsoft Teams

Specific educational objectives	The course belongs to the type "caratterizzanti" and is offered within the Major of Automation. It discusses the principles and standard practices of the programmable logic controllers (PLC) used in industry for automation purposes. At first the principles of digital systems are covered. Programming aspects are introduced afterwards. Finally, practical activities will be carried out during the laboratory hours. The students will therefore learn the following scientific content: • The principles of Boolean logic; • Fundamental logic circuits and logic circuit design. And the following professional skills and knowledge: • What are PLCs, how they are built and how do they work; • How PLC can be programmed using the languages of the IEC 61131-3 standard; • What are the challenges of developing PLC software for a real application and how to solve them.

Lecturer	Anton Soppelsa
Contact	NOI A1.4.27B, anton.soppelsa@eurac.edu
Scientific sector of lecturer	IINF-04/A
Teaching language	English
Office hours	Just after the class or arranged beforehand by email.
Lecturing Assistant (if any)	none
Contact LA	-
Office hours LA	-
List of topics	The main topics of the course are: • Design of logic circuits. Canonical Normal Forms. Optimal synthesis: Karnaugh maps; • Fundamental combinatorial and sequential circuits: building blocks of a Programmable Logic Controller (PLC); • PLCs: structure, IO modules, applications. PLC programming using IDEs; • Moore and Mealy state machines and their implementation in the LD language; • Languages of the IEC 61131-3 standard: Ladder Diagram (LD), Functional Block Diagram (FBD), (Structured Text (ST)); • Hands-on development of supervisory controls using state-of-the-art toolchain and hardware (laboratory activity).
Teaching format	Frontal lessons, exercises and laboratory activities.

Learning outcomes	**Intended Learning Outcomes (ILO)** If followed appropriately, this course will allow the student to acquire the following knowledge and skills. <u>Knowledge and understanding</u> 1. The knowledge to modify, elaborate and design Boolean logic functions; 2. The knowledge to master the most important concepts about programmable logic controller; 3. The understanding of how PLC programming IDE work. <u>Applying knowledge and understanding</u> 4. Ability to recognise the design principles behind real automation systems; 5. Ability to describe the state of the art of the adopted technology; 6. Ability to design and implement a programmatic solution for common automation tasks;

7. Ability to make use of professional-grade IDE for programming PLCs.

Making judgments

8. The ability to select the more adequate automation system and components for a particular application.

Communication skills

9. Acquisition of the technical terminology of the field;
10. Ability to prepare and deliver technical presentations.

Learning skills:

11. Ability to autonomously extend the knowledge acquired during the study course by reading and understanding scientific and technical documentation.

Assessment

The final assessment has both a formative and a summative component. First the students will be evaluated based on their achievements in group-based lab activities. Students that score at least 60% in the formative assessment can take the summative exam, where each student will give a presentation about one of the projects developed in the lab, chosen randomly at the end of the course. Following the presentation, students will answer questions about their project, results, or lectures.

Formative Assessment

Form	%	Length/duration	ILO assessed
Practical (Prc)	50%	5 projects, 24 hours in total	4,5,6,7,8

Summative Assessment

Form	%	Length/duration	ILO asses
Presentation (Prs)	10%	10 min	5,9,10
Oral (Orl)	40%	2 open-questions	1,2,3,4,5,6,8,9,10,11

Students who score less than 60% in the formative assessment have still a chance to demonstrate their programming skills by taking a practical exam where they will set up the hardware and implement a random project from the lab activities within four hours. If a student's laptop can't run TwinCAT software (statistically, only 25% of students can), they may use CodeSys software for solving the exercise virtually. A score higher than 60% will grant access to the summative examination.

Assessment language	English
Assessment Typology	Monocratic
Evaluation criteria and criteria for awarding marks	The final grade is assigned considering the following criteria, independently: • correctness of the developed solution (Prc); • completeness of the developed solution (Prc); • readability of the developed solution (Prc); • appropriate use of measurement units (Prc, Prs, Orl); • ability to establish relationships between topics (Prs, Orl); • ability to provide examples/applications of the theoretical concepts (Prs, Orl); • ability to summarize, evaluate, and presenting the results (Prs, Orl); • clarity and correctness of answers (Prs, Orl); • mastery of technical language (Prs, Orl);

Required readings	The required course material is supplied by the lecturer and will be released during the course.
Supplementary readings	• Dag H. Hanssen, Programmable Logic Controllers (a practical approach to IEC 61131-3 using CodeSys), Wiley • Luca Bergamaschi, Manuale di programmazione dei PLC, 2nd edition, HOEPLI • Flavio Bonfatti, Gianni Gadda and Paola Daniela Monari, Progettazione dei Software PLC secondo lo standard IEC 61131-3, Pitagora Editrice Bologna • Frank Vahid and Tony Givargis, Embedded System Design A Unified Hardware/Software Introduction, Wiley
Software used	*TwinCAT 3, CodeSyS, Arduino PLC*