



Short Training programme *Microcredentials (Open Badge)*

IMPLEMENTATION OF PLC IN AUTOMATIC CONTROL IN INDUSTRY

Training programme prepared by:

PI Technical school Gradiška

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Training programme initiators:

Project: *CL_BVET EDUCATION AND TRAINING FOR COLLABORATIVE
LEARNING IN BLENDED LEARNING ENVIRONMENTS*

Partners of project: JU Tehnička škola Gradiška, Centar za obrazovanje odraslih Banja Luka (Bosnia and Herzegovina), Šolski center Novo mesto, Euroskill d.o.o. (Slovenia), Srednja strukovna škola Velika Gorica (Croatia), Srednja stručna škola Pljevlja, Inovaciono preduzetnicki centar Tehnopolis (Montenegro).



BASIC INFORMATION ABOUT TRAINING PROGRAMME

Title training programme:

Implementation PLC in automatic control in industry

Duration of programme:

50 [hours]

Credit value:

3 ECTS

Educational fields:

- Automation of industrial systems
- Programming and application of PLCs
- Mechatronics and automatic process control
- Maintenance and diagnostics of automated systems
- Digital technologies in industrial production

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Awards and certificates:

Upon successful completion of the programme "Implementation of PLCs in Automatic Control in Industry", participants receive a certificate of completion, confirming the acquisition of knowledge and skills in the fields of industrial automation and process control using PLC systems.

In addition to the certificate, participants are awarded an Open Badge as a digital confirmation of acquired skills. The Open Badge enables verification of knowledge in digital form and its sharing on professional platforms.

The certificate and Open Badge confirm the participant's qualification to perform the relevant tasks.

1. DESCRIPTION AND TARGET GROUP OF THE TRAINING PROGRAMME

Programme Description:

The aim of the programme "Implementation of PLCs in Automatic Control in Industry" is to qualify participants for the independent use of modern industrial automation technologies through working with PLC systems, HMI interfaces, and the preparation of technical documentation within industrial processes.

The programme focuses on enhancing the digital and professional competencies of participants, particularly in the use of software tools for programming and managing automated systems, as well as their practical application on real industrial equipment.

Special emphasis is placed on developing skills in planning, organising, and executing automated processes, while linking theoretical knowledge with practical application in modern industrial environments.

Target group:

The target group of this training programme includes vocational school students and university students in the fields of electrical engineering, mechatronics, robotics, and industrial automation, as well as technicians employed in production and industrial maintenance systems who wish to improve their knowledge and skills in PLC programming and industrial process control.

The programme is also intended for unemployed and employed individuals who wish to acquire or further enhance competencies in the fields of industrial automation, PLC programming, and industrial process control. It is particularly suitable for technicians, production operators, electricians, mechatronic engineers, and individuals who already work or plan to work in industrial automation systems.

Furthermore, the course is aimed at participants who wish to improve their digital competencies and qualify for working with modern software tools and equipment in an industrial production environment.

2. SKILLS

Upon completion of the programme, participants will be qualified to:

- Understand and apply foundational knowledge
- Configure and programme PLC systems and microcontrollers in industrial automation
- Use software tools for programming, simulation, and monitoring of PLC systems
- Operate HMI systems for visualisation, monitoring, and control of automated processes
- Diagnose faults and solve problems in real time
- Develop and document technical solutions through documentation
- Work on improving existing production processes

3. LEARNING OBJECTIVES

Skill 1: **Understanding and Applying Foundational Knowledge**

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Objectives:

- recognise and explain basic electrical quantities and electronic components;
- perform basic measurements of voltage, current, and resistance;
- analyse simple electrical and digital circuits;
- use simulation tools to verify the operation of electronic circuits;
- understand the basic principles of automatic control (open and closed loop);
- connect mathematical and technical process models with real industrial systems;
- use sensor signals and understand their effect on the control logic of the system;
- explain the basic operating principles of PLCs and industrial automation systems;
- configure and programme a PLC in accordance with the requirements of industrial processes;

Skill 2: **Configuration and Programming of PLC Systems and Microcontrollers in Industrial Automation**

Objectives:

- use PLC software tools for creating and editing control programmes (Mitsubishi Alpha, Siemens LOGO, Schneider Zelio, EasySoft, EMCO Ipertu);
- write and test programmes through simulation tools on microcontrollers prior to implementation on a real system;
- optimise the basic components of the system in order to adequately monitor it and perform supervisory control via the PLC, with the aim of achieving system autonomy;

Skill 3: **Using Software Tools for PLC Programming, Simulation, and Monitoring**

Objectives:

- monitor PLC system operation via HMI/SCADA or monitoring software;
- document and store programming solutions using standard digital tools and procedures;
- optimise and adapt programmes based on simulation results and real-world system performance;

Skill 4: **Operating HMI Systems for Visualisation, Monitoring, and Control of Automated Processes**

Objectives:

- explain the role of HMI systems in industrial automation;
- create basic HMI screens for process display;
- connect an HMI with a PLC system;
- monitor and control a process via an HMI interface;

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Skill 5: **Fault Diagnostics and Real-Time Problem Solving**

Objectives:

- use diagnostic tools to identify faults;
- recognise and analyse errors in the operation of automated processes;
- interpret alarm messages, signals, and logs in real time;
- respond to system malfunctions in order to minimise production downtime;
- apply systematic fault-elimination methods in industrial systems;
- collaborate with the team to resolve technical problems efficiently;

Skill 6: **Development and Documentation of Technical Solutions**

Objectives:

- produce electrical and pneumatic diagrams using appropriate software tools;
- document PLC programming solutions;
- prepare a technical description of the implemented system;
- present and archive project documentation in accordance with the assignment;

Skill 7: **Improving Existing Production Processes**

Objectives:

- analyse existing production processes to identify shortcomings and improvement opportunities;
- propose and implement measures to increase system efficiency and productivity;
- optimise workflows by adjusting PLC logic and control parameters;
- evaluate the results of improvements by monitoring system performance and production indicators;

4. PROGRAMME STRUCTURE

No.	Title of Module	Credits (ECTS)	No. hours (h)		
			T	P	TOTAL
1.	Fundamentals of Electrical Engineering and Electronics	0,5	2	1	3
2.	Microcontrollers	0,5	2	3	5
3.	The Concept of PLC – Programmable Logic Controller	0,5	2	3	5
4.	Solving Electro-Pneumatic Control Problems	0,5	2	3	5
5.	Using PLCs in Industrial Production	0,5	1	4	5
6.	Technical Documentation	0,5	2	0	2
TOTAL			11	14	25

MODULE 1: **FUNDAMENTALS OF ELECTRICAL ENGINEERING AND ELECTRONICS**

Objective: To introduce participants to the basic concepts of electrical engineering and electronics (voltage, current, resistance, power, analogue and digital signals) and to develop foundational skills for working with and analysing electrical and electronic circuits through simulation and practical examples.

Content:

- Basic electrical concepts: voltage, current, resistance, and power;
- Measurement of voltage and current in electrical circuits;
- Series and parallel connection of resistors and capacitors (simulation – Falstad Circuit Simulator);
- Determination of resistor values (colour bands and measurement);
- Operating principle of electromagnets and relays;
- Logic gates, flip-flops, timers, counters, and adders (LogiSIM, Falstad);
- Reading and producing electrical diagrams (LibreCAD, AutoCAD);

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Methods:

The programme is delivered through interactive lectures, demonstrations of electrical and electronic circuit operation, software simulations, practical measurement exercises, individual and group work, and problem-solving using concrete practical examples. Special emphasis is placed on learning through simulation and the practical application of basic electronic principles.

MODULE 2: **MICROCONTROLLERS**

Objective:

To qualify participants for the practical application of digital electronics through work with microcontrollers (e.g. Arduino UNO or PIC16F684), including the design, programming, and testing of simple control systems.

Content:

- Selection of equipment for implementing a simple control task;
- Creation of electrical diagrams using software (LibreCAD, QElectroTech, AutoCAD, Fritzing);
- Assembly of an electrical circuit based on the produced diagram;
- Programming of microcontrollers (C language, Arduino, OpenPLC, FLProg);
- Fundamentals of machine code, high-level programming languages, assemblers, and compiler operation;
- Testing and verification of the completed electronic circuit;

Methods:

Instruction is delivered through a combination of interactive lectures, demonstrations of microcontroller system operation, practical laboratory exercises, programming assignments, simulations, and independent participant work. Special focus is placed on learning through practical implementation and testing of the functionality of completed solutions under real or simulated conditions.

MODULE 3: **THE CONCEPT OF PLC – PROGRAMMABLE LOGIC CONTROLLER**

Objective:

To familiarise participants with the structure and operating principles of PLC systems, the basic programming languages used for PLC programming, and the application of HMI interfaces in industrial automated systems.

Content:

- Theoretical foundations of PLC systems (CPU, input/output modules, communication modules);
- Programming languages for PLC (Ladder Diagram – LD, Function Block Diagram – FBD, Structured Text – ST, Sequential Function Chart – SFC);
- Working with PLC programming software (Siemens LOGO, TIA Portal, ZelioSOFT, Mitsubishi ALPHA, EATON EasySoft);
- Simulation of PLC programme operation;
- Basic principles of HMI control and process visualisation;

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Methods:

Instruction is delivered through interactive lectures, PLC system demonstrations, practical programming exercises, simulations of control processes, work on concrete industrial automation examples, and individual and group work. Special emphasis is placed on the practical application of PLC programmes and an understanding of their role in real industrial systems.

MODULE 4: SOLVING ELECTRO-PNEUMATIC CONTROL PROBLEMS

Objective:

To qualify participants to identify and apply electro-pneumatic components, produce electro-pneumatic diagrams, and solve simple control tasks in industrial systems.

Content:

- Basic electrical and pneumatic components and their function in automated systems;
- Operating principle of electro-pneumatic systems;
- Drawing electro-pneumatic diagrams;
- Logical problem-solving of control tasks using relay technology;
- Simulation of electro-pneumatic systems using appropriate software (e.g. FluidSIM);
- Assembly and connection of pneumatic and electrical circuits;
- Testing and verification of system functionality;

Methods:

Instruction is delivered through interactive lectures, demonstrations of electro-pneumatic component operation, simulations using specialised software, laboratory exercises, practical work on equipment, and problem-solving tasks. Special emphasis is placed on connecting theoretical knowledge with practical implementation.

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MODULE 5: USING PLC-s IN INDUSTRIAL PRODUCTION

Objective:

To qualify participants to integrate acquired knowledge in the fields of PLC programming and electro-pneumatic control through the development and implementation of a functional solution for the automation of an industrial process.

Content:

- Analysis and resolution of a given electro-pneumatic control problem;
- Development of a pneumatic system diagram;
- Development of an electrical control diagram;
- Development of a PLC control programming solution;
- Implementation and configuration of HMI process visualisation;
- Connection of the PLC with input/output devices and pneumatic components;
- Testing, optimisation, and commissioning of the system;
- Documentation of the implemented solution;

Methods:

Instruction is delivered through project work, practical laboratory exercises, demonstrations on industrial equipment, simulations of control processes, and problem-solving tasks.

Participants independently and in teams develop and implement functional solutions using PLC controllers, HMI devices, and electro-pneumatic components. Special emphasis is placed on the practical application of acquired knowledge under conditions that simulate real industrial processes.

MODULE 6: TECHNICAL DOCUMENTATION

Objective:

To qualify participants for the preparation and presentation of technical documentation accompanying the implementation of an automated industrial system based on PLC control.

Sadržaj:

- Preparation of a pneumatic solution diagram;
- Preparation of an electrical control diagram using relay technology;
- Preparation of an electrical wiring diagram for the PLC and associated components;
- Documentation of the software solution using Ladder Diagram (LD) and Function Block Diagram (FBD) programming languages;
- Preparation of a technical description of the implemented system;
- Preparation and archiving of project documentation;
- Recording and documentation of the completed pneumatic and PLC system;
- Presentation of the completed project assignment;

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Methods:

Instruction is delivered through practical work on technical documentation, individual project assignments, demonstrations of best practice examples, work with CAD and PLC software tools, and mentored guidance during the preparation of the final documentation. Special emphasis is placed on accuracy, clarity, and the professional preparation of technical documentation in accordance with the requirements of industrial practice.

5. METHOD OF DELIVERY

The training programme is delivered in a classroom, in an automation laboratory using real systems, and online.

The programme is delivered through a blended learning approach, with a total duration of 50 hours, spread over 10 days at 5 hours per day.

The programme comprises:

- **20 hours** of classroom instruction, covering theoretical lectures, demonstrations, and discussions on the fundamental principles relating to the variables used in practice. Instruction integrates theoretical system analysis to prepare participants for subsequent training.
- **20 hours** of practical hands-on laboratory work using equipment, covering the implementation of exercises, programming, and simulation of work tasks. This also includes testing and diagnostics of existing automated systems.
- **10 hours** of guided distance learning (online) via an e-learning platform, covering independent study and analysis of course materials. This component is also intended for consultations with a mentor, where questions beyond the scope of shared learning may be raised.

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By combining theoretical instruction, hands-on laboratory work, and guided distance learning, participants acquire the knowledge and skills required for applying PLC systems in modern industrial processes.

Training methods:

Active learning methods are applied throughout the programme, enabling participants to connect theoretical knowledge with practical application in the preparation and implementation of projects. Training includes interactive lectures, demonstrations, guided discussions, case study work, practical exercises, individual and group work, and the completion of project assignments. Within the guided distance learning component, digital educational materials, self-study tasks, online consultations, and knowledge assessment activities are used. Special emphasis is placed on practical work and the application of acquired competencies to real-world examples from project practice.

6. KNOWLEDGE AND SKILLS ASSESSMENT

The assessment of participants' knowledge and skills is carried out through a practical examination and the defence of a final project assignment.

The practical examination assesses the following skills:

- application of foundational knowledge in electrical engineering, industrial automation, and control systems;
- preparation and analysis of electrical and electro-pneumatic diagrams;
- programming and configuration of PLC devices using appropriate programming languages and software tools;
- preparation and implementation of HMI process visualisation;
- integration of PLCs, sensors, actuators, and other industrial components into a functional automated system;
- use of simulation and diagnostic tools to verify system operation;
- fault diagnostics and optimisation of automated process operation;
- preparation of technical documentation and presentation of the implemented solution.

Through the defence of the final project assignment, participants demonstrate their ability to plan, implement, test, and document an automated control system based on PLC technology.

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The practical examination is conducted in three parts:

1. Completion of the project assignment (industrial automated system), which includes:

- analysis of a given problem from the field of industrial automation;
- preparation of an electrical and/or electro-pneumatic system diagram;
- development of a PLC programming solution;
- preparation of HMI process visualisation;
- testing, diagnostics, and optimisation of system functionality;
- preparation of basic technical documentation.

2. Presentation of the development process and results of the project assignment, along with an explanation of the chosen technical solution, components used, and system operation.

3. Answering questions from the Examination Board to verify understanding of PLC system operating principles, industrial communications, electro-pneumatic control, HMI visualisation, technical documentation, and the application of automation in industrial production.

7. GRADING CRITERIA

The assessment of participants' knowledge and skills is carried out according to the following criteria.

Each criterion is assessed on a scale from 0 to 2 points, with a maximum total score of 14 points [max. 14].

ASSESSMENT CRITERIA:

- Analysis of the assigned task and understanding of the system automation requirements
- Quality of the electrical and pneumatic diagram
- Correctness and functionality of the PLC programming solution
- Quality and functionality of the visualisation on one of the systems (HMI, TouchPanel)
- System testing on equipment and in a simulation environment
- Quality and neatness of technical documentation
- Quality of presentation, professional communication, and responses to Examination Board questions

Each criterion is assessed as follows:

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0 – criterion not met

1 – criterion partially met

2 – criterion fully met



8. CONDITIONS FOR PROGRAMME COMPLETION AND ASSESSMENT OF PERFORMANCE

A participant successfully completes the programme if they achieve a minimum of 8 points out of a possible 14 in the practical examination.

Based on the total number of points achieved, performance is determined as follows:

- **0 – 7 points – failed**
- **8 – 11 points – passed**
- **12 – 14 points – passed with distinction**

Upon completion of the programme, the participant receives a certificate of qualification for the implementation of PLCs in automatic control in industry, including the application of PLC systems, HMI visualisation, electro-pneumatic control, and the preparation of technical documentation for semi-autonomous or fully autonomous systems.



9. PROCEDURE FOR OBTAINING AN OPEN BADGE

School Center Novo Mesto, Šegova street 112, 8000 Novo Mesto

Project: CL.BVET Education and Training for Collaborative Learning in Blended Learning Environments

Website: <https://www.cl-bvet.eu/education-and-training/>

To receive the Open Badge, participants must successfully complete the training programme and fulfil the following requirements:

- successful attendance and completion of the training programme;
- completion of a functional project assignment in the field of industrial automation using a PLC or similar system;
- preparation of accompanying technical documentation (electrical and pneumatic diagrams, PLC programme, and solution description);
- preparation and delivery of a short presentation of the completed project assignment;
- demonstration of the functionality of the implemented solution on equipment or in a simulation environment;
- positive assessment of the project assignment, technical documentation, and presentation by the examination board.

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The Open Badge is awarded to participants who have demonstrated the competencies acquired in PLC programming, industrial automation, HMI visualisation, electro-pneumatic control, and the preparation of technical documentation through practical work and evaluation.

Task Selection:

- The participant selects or is assigned a problem from the field of industrial automation involving the application of a PLC system.
- Based on the task, the participant develops a functional solution comprising a PLC programme, an electrical and pneumatic diagram, and HMI visualisation (if required by the task).
- The use of pre-existing or previously completed solutions is not permitted.
- The project must be independently completed and documented.
- The completed project assignment and technical documentation must be submitted via the link provided below.

Presentation:

- Prepare a short presentation (7–10 slides) presenting the problem, components used, PLC programming solution, system operation, and results achieved.
- The presentation should include photographs, screenshots, or a video recording of the system in operation.
- The presentation must be submitted via the link provided below.



Submission Deadline:

All digital materials (project assignment and presentation) must be submitted no later than 10 days before the date listed on the Notice Board

Application and submission link:

<https://openbadgefactory.com/c/earnablebadge/T419EAaQD80a7B8/apply>

The Open Badge is awarded to participants who successfully complete all of the above steps and whose project assignment and presentation receive a positive assessment.





10. QUALITY ASSURANCE METHODS

QUALITY ASSURANCE IS CARRIED OUT IN ACCORDANCE WITH THE REGULATIONS ON THE QUALITY ASSURANCE SYSTEM FOR SHORT TRAINING PROGRAMMES WITH MICROCREDENTIALS (OPEN BADGE).

