Process Automation

Fall 2026/27

Course code: 63737 • 6 ECTS • Winter semester • Language: English

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When contacting the instructor or teaching assistant by email, please put **63737C** in the subject line. Questions that may also be useful to other students should preferably be posted on the course online classroom.

Brief Course Description

Process automation plays an increasingly important role in modern industrial and computing systems. Automated systems combine software, sensors, actuators, industrial controllers, communication networks, and higher-level information systems to monitor and control physical processes safely and reliably.

In this course, we will study the fundamental building blocks required to design and implement automated systems. We will examine sensors, actuators, programmable logic controllers (PLCs), industrial communication technologies, human–machine interfaces (HMI), SCADA systems, and higher-level manufacturing systems.

A substantial part of the course is practical. Students will work in **pairs throughout the semester** on a single automation project, using industrial PLC equipment and models of industrial processes. Starting with manual device control, each pair will progressively implement automatic control and supervisory functionality.

The scheduled laboratory slots are primarily **project-work sessions**: this is when pairs work together on their system, use the laboratory equipment, test their implementation, and receive guidance. Attendance will not be formally recorded, but regular participation and active work with your project partner are essential for making progress and successfully completing the course.

The semester project contributes **50% of the final grade**; the remaining **50% is obtained through the final oral examination**.

Content Highlights

- **Automation systems and processes**
  Basic concepts of process automation, system components, automation architectures, and control systems.
- **Programmable Logic Controllers (PLCs)**
  PLC architecture, CPU, memory, digital and analogue I/O, execution cycle, and industrial controller hardware.
- **PLC programming**
  IEC 61131 programming concepts, with particular emphasis on Ladder Diagram (LD), Function Block Diagram (FBD), Sequential Function Chart (SFC), and Structured Text (ST).

- **Sensors and actuators**
  Industrial sensors, signal types, motors, pneumatic components, actuators, and their integration with control systems.
- **Human–Machine Interfaces and SCADA**
  Process visualization, operator interaction, alarms, supervisory control, data acquisition, and monitoring.
- **Industrial communication**
  Industrial networks and communication protocols, including serial communication, field buses, Modbus, Profibus, industrial Ethernet, and OPC UA.
- **Higher-level manufacturing systems**
  MES (Manufacturing Execution Systems), integration with enterprise systems, Industry 4.0, and smart-factory concepts.

Learning Outcomes

After successfully completing the course, students should be able to:

- explain the basic principles and architecture of process automation systems;
- identify and understand the roles of sensors, actuators, PLCs, industrial networks, and supervisory systems;
- design and implement PLC programs for industrial control tasks;
- implement manual and automatic control of an industrial process;
- develop basic HMI/SCADA functionality for monitoring and controlling an automated system;
- understand industrial communication technologies and the exchange of information between automation components;
- understand the relationship between PLC-level control, SCADA, MES, and higher-level enterprise systems;
- connect theoretical concepts with their practical application in industrial automation;
- document, demonstrate, and explain the operation of an automated system.

Recommended Background

There are no formal prerequisites beyond those defined by the study programme.

The following knowledge is helpful:

- basic programming concepts;
- basic understanding of computer architecture;
- basic knowledge of computer networks and communication protocols.

Prior experience with PLC programming is **not required**.

Course Meetings

The current weekly timetable is shown below. Please check the official FRI timetable and the course online classroom for any later changes.

Activity	Time	Location
Lectures	Tuesday, 8:15–11:00	P04
Laboratory cycle 1	Thursday, 13:15–15:00	PR17
Laboratory cycle 2	Friday, 9:15–11:00	PR17
Office hours	By arrangement	Please contact the instructor by email

Special events on 8 and 15 December start at different times; see the weekly outline. Timetable changes will be announced on the course website.

Course Resources and Communication

Course website

The course online classroom is the main source for:

- announcements and timetable updates;
- lecture materials;
- laboratory instructions;
- project information and deadlines;
- additional readings and resources;
- course-related discussions.

`https://ucilnica.fri.uni-lj.si/course/view.php?id=41`

Students are responsible for following announcements and updates published on the course website.

Software and Hardware Requirements

The semester project is carried out in pairs. Development will use the Beckhoff TwinCAT environment and related tools.

For preparation and project work outside the scheduled laboratory slots, students may either install the required software locally on a suitable Windows computer or use the virtual machine provided for the course.

The software environment used in the laboratory includes:

- TwinCAT 3;
- TwinCAT 3 HMI;
- Visual Studio;
- TwinCAT OPC UA Server;
- TwinCAT OPC UA Client.

Exact software versions, installation instructions, and the prepared virtual machine will be provided through the course website.

Tentative Course Outline

The schedule below is tentative and may be adjusted during the semester. Any changes will be announced through the course website.

Week	Lectures	Labs
1–2 Oct	No lecture	No labs
5–9 Oct	**Lecture: Introduction and course overview** What is process automation? Basic components, automation architecture, course organisation and project overview.	**Lecture: PLC — Hardware** PLC architecture, CPU, memory, I/O modules, signals, and the PLC scan cycle.
12–16 Oct	**Lecture: PLC Programming, Part I** Ladder Diagram (LD).	**Lecture: PLC Programming, Part II** LD continued; Function Block Diagram (FBD); Sequential Function Chart (SFC); Structured Text (ST).
19–23 Oct	**Lab: Getting to know the software tools and equipment**	**Project work:** Introduction to PLC programming. Ladder Diagram (LD). Manual control of devices.
26–30 Oct	**Lab: Project work — Manual control**	**Project work:** Manual control.
2–6 Nov	**Lecture (3 Nov): PLC Programming — ST examples;** **Sensing and Actuation Components, Part I** Structured Text programming examples; sensors, signal types, measurement, and interfacing.	**Project work:** Manual control.
9–13 Nov	**Lecture (10 Nov): Sensing and Actuation Components, Part II** Actuators, motors, pneumatic systems, and industrial control.	**Project work:** Manual control.
16–20 Nov	**Lab: Project work — Manual control** No regular lecture on 17 November.	**Checkpoint 1: Manual control** Brief demonstrations; remaining lab time for manual-control project work.
23–27 Nov	**Lecture (24 Nov): Human–Machine Interfaces and SCADA** Process visualization, operator interaction, alarms, monitoring, and supervisory control.	**Project work:** Start automatic control.
30 Nov–4 Dec	**Lecture (1 Dec): Industrial Communication, Part I** Industrial networks, serial communication, field buses, RS-422/485, Modbus, and Profibus.	**Project work:** Automatic control.
7–11 Dec	**Company visit — Toplarna (Ljubljana Thermal Power Plant)** **Tuesday, 8 December 2026, at 09:00.**	**Project work:** Automatic control and SCADA where ready.
14–18 Dec	**Guest lecture — INEA d.o.o.** **Tuesday, 15 December 2026, at 09:15.**	**Checkpoint 2: Automatic control** Brief demonstrations; project work on SCADA continues.
21–25 Dec	**Lecture (22 Dec): Industrial Communication, Part II** Industrial Ethernet, OPC UA, and modern industrial communication.	**No labs** Continue project work independently with your partner.
28 Dec–1 Jan	**No class** Work on your projects.	**No labs** Work on your projects.

Week	Lectures	Labs
4–8 Jan	**Lecture: Higher-Level Control Systems** MES (Manufacturing Execution Systems), integration with enterprise systems, Industry 4.0, and the Smart Factory.	**Project work:** SCADA / final project work.
11–15 Jan	**Lecture: Safety, Regulations, and Documentation** Industrial safety, reliability, documentation, and course wrap-up.	**Final project presentations**

Lectures

Laboratory / project work

Student checkpoints / presentations

No class

Course Components

Lectures

Attendance at lectures is strongly recommended. Lectures introduce the concepts and principles needed to make effective progress during the laboratory/project sessions. Students are expected to be familiar with the corresponding material covered in lectures when working on the project.

The course includes a company visit to **Toplarna (Ljubljana Thermal Power Plant) on Tuesday, 8 December 2026, at 09:00**, and a **guest lecture by INEA d.o.o. on Tuesday, 15 December 2026, at 09:15**. Practical details will be announced via the course online classroom.

Laboratory Sessions and Semester Project

The laboratory sessions are dedicated primarily to the semester project. Students will work in **pairs throughout the semester** on the design and implementation of an automation system. The same pair develops the project progressively from:

1. manual control of industrial devices;
2. automatic control of the process;
3. development of HMI/SCADA functionality;
4. integration, testing, presentation, and documentation.

The scheduled laboratory slots are the main time during which students work with their project partner, use the laboratory equipment, receive guidance, test their implementation, and make progress toward the next project milestone. They should therefore be understood primarily as **project-work sessions**, rather than as a sequence of separate laboratory exercises.

Attendance will **not** be formally recorded. However, regular participation in the laboratory sessions and active collaboration with your project partner are essential for making sufficient progress on the project and successfully completing the course.

Both members of the pair are expected to contribute actively and to understand the complete implemented solution.

Project Assessment

Project progress will be evaluated at three points during the semester. The first two checkpoints are brief demonstrations of the current state of the project. After Checkpoint 1 (16–20 November), pairs begin work on automatic control in the following week (23–27 November). SCADA work continues around Checkpoint 2.

Component	Final grade
Checkpoint 1 — Manual control (16–20 Nov)	10%
Checkpoint 2 — Automatic control (14–18 Dec)	10%
Final project presentation (11–15 Jan)	15%
Final written project report	15%
Total project/laboratory work	**50%**

The project report must describe the implemented system, explain its operation, and provide appropriate user and technical documentation.

The submission deadline for the final report will be announced during the semester.

Both project partners are expected to participate in each project checkpoint and in the final presentation.

Final Oral Examination

The final oral examination assesses understanding of the material covered in lectures and laboratory sessions.

A set of practice questions will be provided near the end of the semester.

The oral examination is closed-book: textbooks, notes, and other materials may not be used.

Examination dates will follow the official examination periods and dates published in STUDIS.

Grading

The final grade is calculated as follows:

Component	Weight
Semester project (developed during laboratory sessions)	50%
Final oral examination	50%
Total	**100%**

To pass the course, students must obtain at least:

- **50% of the available project/laboratory points**, and
- **50% of the available oral-examination points**.

Passing one component does not compensate for failing the other.

Academic Integrity and Collaboration

Cooperative learning is encouraged. Students are welcome to discuss lecture material, programming concepts, technical problems, and general solution strategies with their classmates.

However, submitted project work must represent the work of the members of that project pair.

Students must **not**:

- submit duplicate work;
- copy code, documentation, or other project material from another pair;
- copy material from external sources without appropriate acknowledgement;
- have someone who is not a member of the pair produce project work on the pair's behalf.

The final report must clearly state the contribution of each project partner.

Breaches of academic integrity will be handled according to the rules and procedures of the University of Ljubljana and the Faculty of Computer and Information Science.

If you are struggling with the course, please contact the instructor or teaching assistant. We will make every reasonable effort to help you understand the material and successfully complete the course.

Project Work and Pair Participation

The semester project is carried out in **pairs**, with the same two students working together throughout the semester.

Collaboration and discussion between different pairs are welcome, but each pair is responsible for designing, implementing, understanding, and documenting its own solution.

Both project partners are expected to:

- contribute actively to the project throughout the semester;
- understand the complete submitted solution;
- participate in the project checkpoints;
- participate in the final presentation;
- contribute to the final documentation.

Students Requiring Academic Accommodations

Students who require academic accommodations or adjustments are encouraged to contact the instructor as early as possible in the semester.

Official arrangements for students with special status or special educational needs are handled in accordance with the procedures of the University of Ljubljana and UL FRI.

Please consult the current UL FRI information and student services for the appropriate contact person and procedure.

Disclaimer

This course outline is tentative. The instructor may adjust the schedule, individual topics, project deadlines, or course activities when necessary, while remaining within the learning objectives and content of the accredited course. All important changes will be announced through the course online classroom.