COURSE DATA

Data Subject	
Code	34941
Name	Industrial automation
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1404 - Degree in Industrial Electronic Engineering	School of Engineering	2	First term

Subject-matter

Degree	Subject-matter	Character
1404 - Degree in Industrial Electronic Engineering	18 - Industrial automation and control	Obligatory

Coordination

Name	Department
AMOROS LOPEZ, JULIA CARMEN	242 - Electronic Engineering
GOMEZ SANCHIS, JUAN	242 - Electronic Engineering
MUÑOZ MARI, JORDI	242 - Electronic Engineering

SUMMARY

This course will introduce the concepts of control systems and industrial production, introducing the PLC (Programmable Logic Controller) as an essential part of a control system. Internal architecture of PLC and its particular mode of operation will be tackled in depth. Different PLC programming language and procedures will be covered so that a good logical design and programming can be done. Special attention is taken to program with logic diagrams, GRAFCET and GEMMA.

The study of internal architecture and mode of operation of a PLC is also covered. Real-time concepts and applications in industrial automation will be shown, as well as general and specific methods. For example, handling of high speed signals, fast response to events in a specified maximum time, encoder connections, etc. In order to complete the basic skills needed in industrial automation, sensors and actuators are described as they are the main link to PLC from the external world. Presence detection sensor (limit switches, inductive, capacitive, photoelectric, ultrasonic sensors), temperature sensors

(Thermistor, resistors Pt100, NTC, PTC, radiation pyrometers), pressure, etc. will be tackled. Electro-mechanics actuators (contactors), motors (DC, servo, AC, stepper), drives, and pneumatic actuators will be studied. Finally, concepts related to planning and installation of PLC in an industrial environment will be studied, providing examples of installations, wiring diagrams and protections.

The course is divided into three blocks of contents:

BLOCK I. Industrial Automation and Programmable Logic Controllers.

Introduction to industrial control systems.

Programmable logic controllers, architecture and modes of operation.

Programming languages and design of automation systems based on PLC.

Real time concepts in industrial automation and high frequency signals.

BLOCK II. Sensors and actuators in industrial automation.

Features of digital and analog sensors/actuators. Connections. Scaling.

Sensors: Presence, position, speed, force, pressure, level, temperature etc.

Actuators: Electromechanical, motors, hydraulic and pneumatic.

BLOCK III. Maintenance and installation.

Automation projects.

PLC selection.

PLC and sensor installation and verification procedures.

Wiring diagrams and protections.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

No previous knowledge is required, but it is advisable some previous knowledge related to some concepts of control systems and programming.

OUTCOMES

1404 - Degree in Industrial Electronic Engineering

- CG3 - Knowledge of basic and technological subjects that allows students to learn new methods and theories and provides them with versatility to adapt to new situations.
- CG4 - Ability to solve problems with initiative, decision-making skills, creativity and critical reasoning and to communicate and transmit knowledge, abilities and skills in the field of industrial engineering (with specific industrial electronics technology).
- CG6 - Ability to deal with specifications, regulations and mandatory standards.
- CE7 - Knowledge and capacity for systems modeling and simulation.
- CE10 - Applied knowledge of industrial computing and communications.
- CE11 - Ability to design control and automatic industrial systems.

LEARNING OUTCOMES

Learning results after taking the course is summarized in the following skills:

- Applied knowledge of industrial computing and communications (CG3,CG4, CG6, CE7, CE10, CE11).

As a result of the learning, the student will acquire the following skills:

- Choose the appropriate PLC to control a system of industrial production.
- Perform appropriate logic programming in control units of a system of industrial production.
- Understand the real-time concept in industrial automation, and be able to provide comprehensive solution to manage the plant and control signals.
- Select the right types of sensors installed in a production system.
- Appropriate selection of actuators to manage the industrial production process.
- Understand and be able to do the planning stages, choice and installation of PLC in an industrial environment.

In addition to the specific objectives above mentioned, the course will encourage the development of several generic skills, among which include:

- Ability to solve problems with initiative, decision making, creativity and critical thinking.
- Communicate and transmit knowledge, skills and abilities.
- Work in multidisciplinary teams.
- Use and understand technical documentation and user manuals.
- Use documents in English.

DESCRIPTION OF CONTENTS

1. Industrial automation and programmable logic devices

Introduction to industrial control systems.
1.1. Introduction.
1.2. Control systems.
1.3. Automation systems.
1.4. PLC.
1.5. Industrial computers.

Design methods.
2.1. Combinational and sequential automation systems.
2.2. Classical design methods.
2.3. Logic equations based methods.
2.4. GRAFCET.
2.5. GEMMA.

PLCs.
3.1. Block Diagrams.
3.2. Central Processing Unit.
3.3. Memory.
3.4. Input/Output Map.
3.5. PLC selection.
3.6. Block programming.
3.7. Ladder diagram programming.
3.8. Assembler programming.

Operation and configuration.
4.1. Operating cycle.
4.2. Checks.
4.3. Estimation of scan cycle.
4.4. Real time concepts.
4.5. Fast signal management.
4.6. Settings in a control unit.
4.7. Configuration of inputs and outputs.

2. Sensors and actuators in industrial automation

Common peripherals in industrial automation
5.1. Types, connections, scaling.
5.2. Proximity sensors.
5.3. Position, distance and displacement meters.
5.4. Transducers.
5.5. Electrical actuators.

5.6. Hydraulic and pneumatic actuators.

3. Commisioning and maintenance

Installation of PLCs.
6.1. Projects.
6.2. PLC selection.
6.3. Industrial automation system installation.
6.4. Wiring diagrams and electrical protections.

4. Industrial Automation Laboratory

The students will undertake the following practical sessions:

Introduction to to generic programming software
Pump control for tank filling.
Introduction to to PLC programming software: Control of a load wagon.
PLC programming of a crane.
Transfer machine with three simultaneous actions.
Control inputs and analog outputs for PLC.
Individual examinaron.

Additionally, as a homework, two projects will be required:

Sensors and actuators project.
Installation of an industrial automation project.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Laboratory practices	20,00	100
Classroom practices	10,00	100
Development of group work	5,00	0
Development of individual work	5,00	0
Study and independent work	30,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	10,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	15,00	0
Resolution of case studies	5,00	0

Resolution of online questionnaires	5,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The teaching methodology to be used will be different depending on the type of subject to be analysed, the contents of each class and the activities to be developed in each session at theory, problems and laboratory.

Specifically, in the theory part, master class sessions will be carried out, supported by a debate among students on certain topics of interest. After some theoretical class sessions, work tasks will be proposed to the student to be discussed in the next class. Some of these tasks will be evaluable.

The practical and problem classes will be proposed in advance to the students, and will be solved in class or as homework to consolidate knowledge. The participation of students will be appreciated when solving problems and present their contributing ideas and solutions. In addition, an individual project will be carried out during the course, which will be evaluated by the students and the teacher.

Regarding the laboratory classes, they will be carried out with simulation material and / or hardware elements related to the subject. Each laboratory session will have a document detailing the activities to be carried out, the objectives to be achieved and the pre-practical work that the student must carry out to adequately achieve the practical objectives. The laboratory classes will be evaluable, both for the monitoring and participation of the student in the class and for the tasks/questionnaires that must be done before and after each practice.

The student will have access to the teaching material related to the subject (transparencies, articles, web addresses, manuals, references for extension, etc.) and to the scheduled activities during the course through the Virtual Classroom of the UV. In addition, the use of the discussion forums as a tool to improve learning cooperatively and/or collaboratively will be encouraged.

With this teaching methodology and the proposed activities, all the competences of this subject will be carried out (CG3, CG4, CG6, CE7, CE10, CE11).

EVALUATION

The evaluation in the learning of the knowledge and competences achieved by the students will be carried out continuously throughout the course.

In the first call, the student will be able to choose between two evaluation modalities:

- **CONTINUOUS EVALUATION (CE) mode**, which will consist of the following evaluation blocks (Note: All percentages are referred to the final grade):

a) **EX1**: Objective test, consisting of one or more exams consisting of both theoretical-practical questions and problems (40%)

b) **CE1**: Continuous evaluation of each student, based on the student's participation and degree of involvement in the teaching-learning process, taking into account regular attendance at the scheduled face-to-face activities and the resolution of questionnaires and problems periodically proposed in the theoretical-practical classes. In addition, an automation project will be carried out (30%).

1. **CE1-1**: Questionnaires carried out during the course by topic or subject (10%). NON-RECOVERABLE activity.
2. **CE1-2**: Problem solving and participation in dialogues and debates during the classes and also in the proposed activities and tasks at the Virtual UV Classroom (10%). NON-RECOVERABLE activity.
3. **CE1-3**: Perform an individual automation project, including some evaluation activities (10%). NON-RECOVERABLE activity.

c) **CELAB**: The final laboratory evaluation is a result of the continuous evaluation of each session and the completion of a practical test that will assess the student's knowledge acquired during the course (30%).

The mark obtained by the continuous evaluation modality (NOTE_CE) will therefore be obtained as follows:

NOTE_CE = 0.4 * EX1 + 0.3 * mean(CE1-1 + CE1-2 + CE1-3) + 0.3 * CELAB

* It will be an essential condition to pass the subject that the student obtain a grade equal to or greater than 4 in each of the parts in which the subject is structured (EX1, CE1 and CELAB) to be able to take an average. The average mark obtained must be equal to or greater than 5 (out of 10). Otherwise, the student must present to the final exam modality in order to pass the course.

- **Final Exam Mode (FEX):**

There will be a final theory-problems and laboratory exams on the date set by the ETSE-UV. The Theory-Problems grade accounts to the 70% of the mark, and the laboratory the 30% of the rest of the mark. Note: All percentages are based on the final grade.

NOTE_FEX = 0.7 * EX_T-P + 0.3 * EX_LAB

* Note that the student needs to obtain a grade equal to or greater than 5 in each part to pass the subject.

In the second call, the student will always be evaluated by the final exam modality.

REFERENCES

Basic

- Autómatas Programables, J. Balcells, J. L. Romeral. Marcombo. 1997. ISBN: 84-267-1089-1.
- Autómatas Programables. Entorno y Aplicaciones. E. Mandado, J. Marcos, etc. Thomson / Paraninfo. 2005.
- Autómatas Programables, A. Simon. Paraninfo. 1995. ISBN: 84-283-1578-7.

Additional

- Automating with SIMATIC. Berger, Hans.