Universidad de Navarra

Automatización e Instrumentación Industrial (Ing.Gr.)

Teaching guide 2026-27

PRESENTACIÓN/PRESENTATION

Breve descripción/ Brief description:

This course covers the basic knowledge required to deploy automatic machines in the context of XXI century, that is to say, (re)programmable and connected machines. Thus, the main target for the couse is the learning how to programme the two most used devices over the world to control machines in industry: Programmable Logic Controllers (PLC) and robot controllers. Regarding to how to programme PLCs, the Ladder and Structured test are reviewed. In orde to connect the, some lectures cover basic concepts for Fieldbuses and IoT communication protocols. Finally, some lectures are booked for the review of the most important components of automatic machines (actuators, sensors, transmition mechanisms, etc).

Titulación/Degree (Módulo/Materia):

- Ingeniería en Electrónica Industrial (Bloque Especializado de Electrónica Industrial /Sistemas Digitales y Control)

Detalles/Details:

- **ECTS**: 6 ECTS
- **Curso, semestre**: 4.º curso, 2.º semestre
- **Carácter**: Obligatorio
- **Idioma**: The lectures are mainly delivered in Spanish and the documentation is mainly in English

Profesores de la asignatura/Lecturers:

- Sánchez Tapia, Emilio José/Profesor titular
- Gutiérrez Calderón, José Sebastián/Profesor titular
- Laurent, Julie / Colaborador docente

COMPETENCIAS/SKILLS

INGENIERÍA EN ELECTRÓNICA INDUSTRIAL

CG10 - Capacidad de trabajar en un entorno multilingüe y multidisciplinar.

CE25 - Conocimiento y capacidad para el modelado y simulación de sistemas.

CE26 - Conocimientos de regulación automática y técnicas de control y su aplicación a la automatización industrial.

CE27 - Conocimientos de principios y aplicaciones de los sistemas robotizados.

CE28 - Conocimiento aplicado de informática industrial y comunicaciones.

CE29 - Capacidad para diseñar sistemas de control y automatización industrial.

PROGRAMA/PROGRAMME

Chapter 1. Introduction to Industrial Automation

- Automated System
- Wired logic vs. programmable logic
- Centralised vs. distributed systems
- SCADA
- Automation pyramid

Chapter 2. Industrial networks

- Introduction to fieldbus and industrial networks
- ISO OSI model: the basic reference model for protocols
- Key concepts
- Protocols commonly used in automation

Chapter 3. PLC basics

- Introduction to PLCs
- PLC-based Process Control
- First steps with a PLC

Chapter 4. IEC 61131 Languages

- Introduction
- IEC61131 Programming Languages
- Most common functions/function blocks available for all languages

Chapter 5. Sequential Function Chart (SFC or GRAFCET) and GEMMA

- Sequencial programming using SFC
- GEMMA (Guide d'Etudes des Modes de Marches et d'Arrêts)

Chapter 6. Introduction to PLCopen motion control of a single axis

- Introduction
- Getting started
- Overview of the defined function blocks
- Graphical vs. textual representation
- PLCopen motion state machine
- Error handling
- FB interface
- Homing procedures

Chapter 7. Coordinated Motion

- Camming and gearing
- Multi-axis coordinated motion

Chapter 8. Introduction to Robotics

- Introduction
- A little about the History
- The technological roots of robotics
- First approach
- Basic Terminology in Robotics

Chapter 9. Introduction to Industrial Robotics

- Some definitions of industrial robots
- Robot generations
- Industrial applications

Chapter 10. Industrial robot programming

- Introduction
- Levels of robot programming
- Robot programming methods
- Examples of robot programming languages
- Robot programming language architecture
- Robot program development process: the six stepts

Chapter 11.Robot geometry

- Dimensions and Degrees of Freedom (DoF)
- Types of joints
- The geometry of robot manipulators

Chapter 12. Basic components of mechatronic systems

- Introduction
- Links
- Actuators and motors
- Reduction mechanisms
- Sensors
- Proximity sensors
- End-effectors and terminal devices

Chapter 13. Internet of Things (IoT) and Industrie 4.0

- Introduction to industrie 4.0
- Iot and cibersecurity
- Nodered
- OPC-UA/MQTT
- Databases
- Machine monitoring by dashboards
- Connectivity with clouds

Practical sesions

TwinCat Studio and Beckhoff PLC (OT)

node-red, influx and grafana (IT)

Stäubli Robot programming (RoboDK)

ACTIVIDADES FORMATIVAS / EDUCATIONAL ACTIVITIVES

Methodology:

- Lectures: presenting the required theoretical background following the classnotes (PLC Programming and Robot Control and Programming by Emilio Sánchez) and further documents available in ADI
- Guided practical sessions:
  - programming PLCs and IoT conectivity (6 weekly actitivies)
  - programming Robot sessions
- Team-work Assignment: course project (IT/OT programming)
- Videos and several digital resources at this web page
- The forum available at this web page

The course is mainly practical.

EVALUACIÓN / ASSESSMENT

Universidad de Navarra

FIRST SIT

The assesment of the course is as it is described following:

- 45% Examination (threshold 50%), Theory+exercise : 5 points (threshold 2.5)
- 55% Compulsory practical exercise
  - Group practicals (2.4 points)
  - Course project (2.6 points)
  - ROBOT programming (1 points)

Notice 1: there is a minimum required exam grade (2.5pts over 5pts) for the practicum to be factured in for final grade calculation. The final evaluation is measured over 10 points despite the fact the student can get 11 points.

Notice 2: After the written exam, the lecturer may invite some students to explain their answers orally. Such an invitation may take place up to one week after the written exam has been completed. *[Spanish] Con posterioridad a la prueba escrita, el profesor podrá convocar a algunos estudiantes para que expliquen verbalmente sus respuestas. Esta convocatoria podrá tener lugar hasta una semana después de realizada la prueba escrita*.

OTHER SITS

There is not possibility of performing any supplementary practicals. The only valid way to pass the subject is a written examination (10 points).

ECTS GRADE EQUIVALENCE

(this table is only orientative, to make easier for Erasmus people to understand the Spanish grade system, not valid for certification purposes)

Numerical Value	**TECNUN Grade**	**ECTS Grade**
Below 4	Suspenso (SS) Fail	F
Equal of more than 4 and below 5	Suspenso (SS) Fail	Fx
Equal of more than 5 and below 7	Aprobado(AP) Sufficient	C,D,E
Equal of more than 7 and below 9	Notable(NT) good	B
Equal of more than 9 and below 10	Sobresaliente (SB) very good	A

10	Matrícula de Honor (MH) excellent	A+

EXAMINATION LANGUAGE

The written examination is delivered in English and the students will be able to choose to answer the questions in either Spanish or English. But, in the scope of every question, a language mixture is not admitted.

HORARIOS DE ATENCIÓN / TUTORING

- Highly Recommended During the class
- Less recommended by email :
  - Sánchez Tapia, Emilio José - Email: esanchez@ceit.es
  - Gutiérrez Calderón, Sebastián - Email: jsgutierrez@tecnun.es

In case the students have any questions related to the subject, they are free to book tutoring sessions when they require.

BIBLIOGRAFÍA/BIBLIOGRAPHY

BIBLIOGRAFÍA BÁSICA/ BASIC BIBLIOGRAPHY

E. Sánchez. "PLC programming: class notes". TECNUN 2015.

E. Sánchez. "Introduction to Industrial Robots: class notes". TECNUN 2015

BIBLIOGRAFÍA COMPLEMENTARIA/ ADDITIONAL BIBLIOGRAPHY

W. Bolton. "Programmable Logic Controllers". Elseviers Newnes. 2010 Localízalo en la biblioteca (formato papel y electrónico)

A. Porras, A.P. Montanero. "Autómatas programables". McGraw-Hill Localízalo en la biblioteca

J. Balcells, J. L. Romeral. "Autómatas programables". Marcombo . Localízalo en la biblioteca

A. Ghosal. "ROBOTICS Fundamental Concepts and Analysis". Oxford University Press, 2006 Localízalo en la biblioteca

J.J. Craig. "Introduction to Robotics, Mechanics and Control". Addison Wesley, 2005 . Localízalo en la biblioteca

L. M. Thomson. "Industrial Data Communications"ISA 2008 Localízalo en la biblioteca

WEBS

This web page

https://www.plcopen.org/

https://www.ifr.org/



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ACKNOWLEDGMENTS / SPONSORS

https://robodk.com

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