COMILLAS
UNIVERSIDAD PONTIFICIA
ICAI ICADE CIHS

COURSE SYLLABUS 2020-2021

GENERAL INFORMATION

Course information	
Name	Smart Systems Applied to Industry
Code	DEA-MIC-512
Degree	Máster Universitario en Ingeniería Industrial + Máster en Industria Conectada [1st year]
Semester	1st (Fall)
ECTS credits	6.0
Type	Compulsory
Department	Electronics, Control and Communications
Coordinator	Álvaro Sánchez Miralles

Lecturer	
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Lab Instructor	
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DETAILED INFORMATION

Contextualization of the course

Contribution to the professional profile of the degree

The purpose of the course is to provide students with a basic overview of the smart system concept and its application to Industry 4.0.

By the end of the course, students will:

- Know the basic features that define a smart system.
- Have practical experience designing and dealing with smart industry applications.
- Be able to develop medium complexity data models for smart systems, and to implement them in MySQL.
- Be able to develop simple C++ programs to implement smart algorithms and modules for Industry 4.0.

Prerequisites

Students willing to take this course should be familiar with undergraduate-level programming.

CONTENTS

Contents

Theory

Unit 1. Introduction to smart systems

1.1 Main features
1.2 Architecture
1.3 Smart systems design
1.4 Application to smart industry

Unit 2. Smart systems data model design and implementation

2.1 Data models: conceptual, logical, and physical
2.2 Hot to manipulate data: DML and DDL
2.3 Implementation in MySQL

Unit 3. Smart systems programming

3.1 Object oriented design
3.2 Classes, constructors, destructors, and attributes
3.3 Operators and member functions
3.4 Inheritance and polymorphism
3.5 Implementation in C++: basic standard library template

Laboratory

Lab 1. Selection of a project application

Business analysis, actors, and architecture definition.

Lab 2. Data model design

MySQL database training.

Lab 3. Project design

C++ application programming training.

Lab 4. Project development

Competences and learning outcomes

Competences[1]

General competences

CG1.	Have acquired advanced knowledge and demonstrated, in a research and technological or highly specialized context, a detailed and well-founded understanding of the theoretical and practical aspects, as well as of the work methodology in one or more fields of study. *Haber adquirido conocimientos avanzados y demostrado, en un contexto de investigación científica y tecnológica o altamente especializado, una comprensión detallada y fundamentada de los aspectos teóricos y prácticos y de la metodología de trabajo en uno o más campos de estudio.*
CG2.	Know how to apply and integrate their knowledge, understanding, scientific rationale, and problem-solving skills to new and imprecisely defined environments, including highly specialized multidisciplinary research and professional contexts. *Saber aplicar e integrar sus conocimientos, la comprensión de estos, su fundamentación científica y sus capacidades de resolución de problemas en entornos nuevos y definidos de forma imprecisa, incluyendo contextos de carácter multidisciplinar tanto investigadores como profesionales altamente especializados.*
CG5.	Be able to transmit in a clear and unambiguous manner, to specialist and non-specialist audiences, results from scientific and technological research or state-of-the-art innovation, as well as the most relevant foundations that support them. *Saber transmitir de un modo claro y sin ambigüedades, a un público especializado o no, resultados procedentes de la investigación científica y tecnológica o del ámbito de la innovación más avanzada, así como los fundamentos más relevantes sobre los que se sustentan.*
CG6.	Have developed sufficient autonomy to participate in research projects and scientific or technological collaborations within their thematic area, in interdisciplinary contexts and, where appropriate, with a high knowledge transfer component. *Haber desarrollado la autonomía suficiente para participar en proyectos de investigación y colaboraciones científicas o tecnológicas dentro de su ámbito temático, en contextos interdisciplinares y, en su caso, con una alta componente de transferencia del conocimiento.*
CG7.	Being able to take responsibility for their own professional development and their specialization in one or more fields of study. *Ser capaces de asumir la responsabilidad de su propio desarrollo profesional y de su especialización en uno o más campos de estudio.*

Specific competences

CE1.	Have an overview of the connected industry. Be able to explain in which areas can substantial improvements be obtained through the application of digital techniques and technologies. *Tener una visión general de la industria conectada. Ser capaces de explicar en qué áreas pueden obtenerse mejoras sustanciales por la aplicación de técnicas y tecnologías digitales.*
CE2.	Be able to design smart systems of direct application in the new context of the connected industry. *Ser capaces de diseñar sistemas inteligentes de aplicación directa en el nuevo contexto de la industria conectada.*

[1] Competences in English are a free translation of the official Spanish version.

Learning outcomes
By the end of the course students should:
RA1. Understand the basic principles behind smart systems.
RA2. Be able to conduct research on smart industry topics.
RA3. Have practical experience in the development of data models.
RA4. Be capable of developing smart applications for industrial systems.
RA5. Improve their team working abilities.
RA6. Demonstrate enough initiative, creativity and autonomy to propose and develop a real project related to smart industry.

TEACHING METHODOLOGY

General methodological aspects

Theory and practice will be combined along the course. The teacher will explain the basics of the subject and will go into depth in the more important issues with illustrative examples. Students will form groups to put the proposed methods and techniques in practice in a collaborative way.

In-class activities	Competences
▪ **Lectures and problem-solving sessions:** The lecturer will introduce the fundamental concepts of each unit, along with some practical recommendations, and will go through worked examples to support the explanation. Active participation will be encouraged by raising open questions to foster discussion and by proposing short application exercises to be solved in class either on paper or using a software package.	CG1, CG7, CE1, CE2
▪ **Lab sessions:** Under the instructor's supervision, students, divided in small groups, will apply the concepts and techniques covered in the lectures to real problems and will become familiar with technologies used in the development of smart solutions in the context of Industry 4.0.	CG1, CG2, CG5, CG6, CG7, CE1, CE2
▪ **Tutoring** for groups or individual students will be organized upon request.	–
Out-of-class activities	**Competences**
▪ Personal study of the course material and resolution of the proposed exercises.	CG1, CG7, CE1, CE2
▪ Lab session preparation, programming and reporting.	CG1, CG2, CG5, CE2
▪ Development of a final project in small groups.	CG1, CG2, CG5, CG6, CG7, CE1, CE2

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Weight
Continuous evaluation	▪ Understanding of the theoretical concepts. ▪ Application of these concepts to problem-solving.	10%
Final exam	▪ Understanding of the theoretical concepts. ▪ Application of these concepts to problem-solving.	30%
Lab assignments	▪ Application of theoretical concepts to real problem-solving. ▪ Ability to develop code for smart systems. ▪ Attitude and effort: Initiative and proactive work will be encouraged ▪ Written communication skills. ▪ There will be an intra-group evaluation method to differentiate among team members.	30%
Final project	▪ Problem analysis and design ▪ Quality of the project implementation. ▪ Teamwork ▪ Oral presentation skills. ▪ There will be an intra-group evaluation method to differentiate among team members.	30%

GRADING AND COURSE RULES

Grading

Regular assessment

- **Theory** will account for 40%, of which:
  - Continuous evaluation: 10%
  - Final exam: 30%
- **Lab** will account for the remaining 60%, of which:
  - Lab assignments: 30%
  - Final project: 30%

In order to pass the course, both theory and laboratory marks must be greater or equal to 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.

Retake

There will be a final exam worth 100% of the grade. It will include both theoretical and practical questions.

Course rules

- Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Comillas Pontifical University and Article 6 of the Academic Rules (Normas Académicas) of the ICAI School of Engineering. Not complying with this requirement may have the following consequences:
  - Students who fail to attend more than 15% of the lectures may be denied the right to take the final exam during the regular assessment period.
  - Regarding laboratory, absence to more than 15% of the sessions can result in losing the right to take the final exam of the regular assessment period and the retake. Missed sessions must be made up for credit.
- Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (Reglamento General) of Comillas Pontifical University).

WORK PLAN AND SCHEDULE[2]

In and out-of-class activities	Date/Periodicity	Deadline
Continuous evaluation activities to review and study the concepts covered in the lectures	Periodically on demand	–
Final exam	Last week	–
Lectures and lab sessions	Weekly	–
Review and self-study of the concepts covered in the lectures	Weekly	–
Final project development	Weekly	–

STUDENT WORK-TIME SUMMARY		
IN-CLASS HOURS		
Lectures	**Lab sessions**	**Assessment**
28	28	4
OUT-OF-CLASS HOURS		
Self-study	**Lab preparation and report writing**	**Final project**
30	30	60
	ECTS credits:	**6 (180 hours)**

BIBLIOGRAPHY

Basic bibliography

- Slides prepared by the lecturer (available in Moodlerooms).

Complementary bibliography

- B. Stroustrup, *The C++ Programming Language*, 4th Ed., Addison-Wesley Educational Publishers, 2013. ISBN-13: 978-0-321-56384-2
- R. Elmasri and S. B. Navathe, *Fundamentals of Database Systems*, 7th Ed., Pearson Education, 2016. ISBN-13: 978-1-292-09761-9
- MySQL documentation, [Online]. Available: https://dev.mysql.com/doc/

[2] A detailed work plan of the subject can be found in the course summary sheet (see following page). Nevertheless, this schedule is tentative and may vary to accommodate the rhythm of the class.

TENTATIVE SCHEDULE															
THEORY	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
1. Introduction to smart systems															
2. Smart systems data model design and implementation															
3. Smart systems programming															
LABORATORY	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
Lab 1. Selection of a project application															
Lab 2. Data model design															
Lab 3. Project design															
Lab 4. Project development															