EMBEDDED SYSTEMS AND INTERNET OF THINGS: ARCHITECTURE AND DEVICES (EMaCS-01-03)				
DEGREE PROGRAM:		Master in Computer Science for the Human-Centric and Sustainable Industry		
SEMESTER: First	**TYPE:** Basic	**CREDITS:** 6 ECTS	**WORKLOAD:** 150 hours	**MENTORING:** 4 hours/week
LANGUAGE: English				

OBJECTIVES	
General	The student will learn both the theoretical framework and practical skills surrounding embedded systems and IoT devices, communication technologies and architectures.
Specific	• Know the architecture, operating systems and interfaces used for embedded systems. • Know the principles underlying the different communication technologies in IoT and how they work. • Know how to choose among the different communication technologies in IoT for each specific scenario. • Apply the IoT knowledge to real-world scenarios for the design and deployment of IoT solutions. • Understand the most typical protocols in the application layer for IoT. • Understand the model of publish-subscription of messages. • Understand the relevance of security issues when sending data from IoT devices to remote servers.

SUSTAINABILITY

The course "Embedded Systems and Internet of Things: Architecture and Devices" significantly contributes to sustainability by addressing specific competencies and objectives that incorporate ethical considerations, conscientious selection of communication technologies, and the application of IoT knowledge in real-world scenarios. The focus on ethics emphasizes the importance of considering sustainability impacts when implementing IoT solutions. Attention to data transmission security from IoT devices reinforces the importance of designing systems that are secure and privacy-respecting. Weighing the risks and benefits of IoT solutions for industry also highlights the importance of sustainability considerations in technology decisions.

RESILIENCE AND HUMAN-CENTRIC DEVELOPMENT

The course promotes resilience and human-centred development by addressing competencies that promote understanding of the publish-subscribe messaging model, identification of appropriate technologies for specific IoT scenarios, and consideration of risks and security issues. The application of IoT knowledge to real-world scenarios highlights the relevance of designing solutions that meet specific user needs. Consideration of ethical risks, privacy, and ethical considerations in the development and deployment of IoT systems emphasizes the importance of resilience and human-centric considerations in the design of emerging technologies. Willingness to stay informed about IoT trends reflects a mindset of continuous learning and adaptability, essential aspects for human-centred development and resilience in changing technological environments.

SUBJECT MATTER

1. Introduction to Internet of Things and embedded systems for real time. Basic concepts.
2. Interfaces and operation modes in embedded systems. Basic concepts.
3. Design and development of embedded applications.
4. Operating systems for embedded devices.
5. Architectures for IoT systems.
6. Communication protocols for IoT.
7. Application layer protocols for IoT.
8. Use cases for embedded and IoT systems.

COMPETENCES

C2. BROWSING, SEARCHING AND FILTERING DATA, INFORMATION AND DIGITAL CONTENT
C3. MANAGING AND EVALUATING DATA, INFORMATION AND DIGITAL CONTENT
C5. PROGRAMMING
C7. PROTECTING PERSONAL DATA AND PRIVACY
C10. EXPLORATORY AND CRITICAL THINKING
C13. CREATIVELY USING DIGITAL TECHNOLOGIES
C17. COMMUNICATING EFFECTIVELY
C18. COLLABORATING THROUGH DIGITAL TECHNOLOGIES

LEARNING OUTCOMES

Knowledge	• Know the most widely used communication technologies in IoT and technical details about how each of them works. • Know the components involved in an IoT architecture. • Know the several different IoT architectures and what components are part of each of them. • Know the architecture and peculiar characteristics of an embedded device. • Know how to design, program and deploy an embedded system.
Skills	• Understand the publish-subscription message model. • Be able to identify what communication technology is most appropriate depending on each specific IoT scenario. • Be able to identify the security risks and issues that arise in IoT environments. • Be able to design and deploy secure communication networks in IoT environments. • Be able to design and develop applications and services using an embedded system. • Understand how to apply their knowledge on IoT and translate it to real case scenarios for designing and deploying solutions satisfying a set of requirements.
Attitudes/values	• Weight the benefits and disadvantages of using IoT solutions for industry and its effects on sustainability. • Ponder the privacy and data leakage risks of IoT devices. • Consider ethics (including but not limited to human agency and oversight, transparency, non-discrimination, accessibility, and biases and fairness) as one of the core pillars when developing or deploying IoT systems. • Have a good disposition to keep learning, to educate oneself and stay informed about IoT and embedded devices trends.

TEACHING METHODS

Method	Class Workload	Individual Workload	Total
Theoretical Sessions (masterclass, seminars, etc.)	24	24	48
Laboratory Sessions	24	42	66
Research and collaborative work on an applied project	4	30	34
Written Exams	2	0	2
TOTAL	**54 hours**	**96 hours**	**150 hours**

EVALUATION

Evaluation Procedure	Percentage on the course grade
Continuous Assessment (participation, problem solving during masterclasses, etc.)	10%
Deliverable Assignments and Reports (individual work)	30%
Applied Project (collaborative work)	30%
Written Exams	30%
TOTAL	**100%**

In order to pass the course, it is necessary to obtain a minimum mark of 4 out of 10 in each of the four evaluation procedures and 5 out of 10 in their weighted average.	
PRECONDITIONS	
A solid knowledge, at graduate level, about electronics, programming, computer networks and computer architecture is recommended before undertaking this course.	
DEPARTMENT	Department of Digitalization
LECTURERS	Rubén Ruiz González
LITERATURE	• B. Chaudhari, M. Zennaro, (eds.) LPWAN Technologies for IoT and M2M Applications. Academic Press, 2020 • Q. F. Hassan, Internet of Things A to Z: Technologies and Applications. Wiley-IEEE Press, 2018. • A. Gilchrist, Industry 4.0: The Industrial Internet of Things. Berkeley, CA, USA: Apress, 2016. • A. Bahga & V. Madisetti, Internet of Things: A hands-on approach. Hyderabad, India: Universities Press, 2017. • E. A. Lee and S. A. Seshia. Introduction to Embedded Systems - A Cyber-Physical Systems Approach. Second Edition, MIT Press, 2017. • E. White. Making Embedded Systems. O'Reilly Media, Inc, 2011.