# Mobile Devices

Code: 104374
ECTS Credits: 6

2024/2025

| Degree | Type | Year |
|---|---|---|
| 2503758 Data Engineering | OT | 4 |

## Contact

Name: Jordi Carrabina Bordoll

Email: jordi.carrabina@uab.cat

## Teachers

Marc Codina Barbera

## Teaching groups languages

You can view this information at the end of this document.

## Prerequisites

The course is self-contained and therefore there are no specific pre-requisites.

## Objectives and Contextualisation

Description:
The ICT world is being structured on various concepts. One of them is the Internet ofThings, which is based on expanding the computing domain to connected objects (devices)of small size and energy consumption that interact with the real world via sensors andactuators in different areas: personal / wearables, health, home automation, environment,energy and water distribution, automotive, etc. These connect through various protocols toa fixed or mobile intermediate platform (edge) that manages, filters and processes part ofthe data locally. In turn, it is connected to the cloud where the data is stored, processedand displayed. The implementation of these systems requires integrating the variousconcepts, acquired in previous courses, in this new device-edge-cloud paradigmassociated with different types of computing platforms (single-, multi-, many-coreprocessors) with different requirements of functionality, power, latency, bandwidth and cost;different programming and communication models; and different cloud options for back-endand front-end, so a higher level of abstraction is required at the interface level (APIs andMiddleware) and virtualization (computing and communications).

Goals:
Establish the fundamentals of the internet of things (IOT): device, periphery (edge) andcloud (cloud); together with the user interfaces.
Learn to classify embedded processors, sensors, actuators, and systems, and selectcommunications protocols and cloud options

Evaluate the functional requirements and the performance in terms of cost, real timecomnditio and energy efficiency
Evaluate the cost of data structures based on sensors, computing, communication, storageand visualization at each level.
Select embedded and mobile platforms for the edge and cloud solutions for back-end andfront-end
Manage the virtualization of computing and communications
Design a theoretical and practical example case of the entire IoT chain for a specificapplication

(this subject is given together with the Internet of Things subject of the Bachelor's Degree in Informatics Engineering)

## Competences

- Conceive, design and implement the most appropriate data acquisition system for the specific problem to be solved.
- Work cooperatively in complex and uncertain environments and with limited resources in a multidisciplinary context, assuming and respecting the role of the different members of the group.

## Learning Outcomes

1. Design the most efficient data acquisition system for a system to support autonomous driving.
2. Work cooperatively in complex and uncertain environments and with limited resources in a multidisciplinary context, assuming and respecting the role of the different members of the group.

## Content

Lectures
1. Global View of the Internet of Things & Virtualization

- IoT Systems: Functionality & Architecture. Device, edge, cloud, UI
- Cloud back-end & front-end
- Virtual platforms for embedded systems
- Virtual platforms for cloud systems: IaaS, PaaS, SaaS
- Communications Virtualization

2. Introduction to Wired & Wireless Communications

- Communications standardization
- Wired Protocols for device, edge & cloud
- Wireless Networks for device to edge: WBAN, WPAN, WLAN, LPWAN
- Wireless Networks for edge to cloud: WLAN, WAN, LPWAN, 5G
- Communications data frames

3. Embedded and mobile platforms

- Embedded platforms: open & industrial
- Platform examples
- Mobile platforms

4. IoT devices

- Examples and Use Cases
- HW Components: processors, sensors, actuators, batteries

- Performance: cost, real-time (latency, throughput), and energy efficiency
- Standards and Intellectual property

Guided project: Design of an (original) IoT system
P1. Original ideas for the design of an IoT system and preliminary market study
P2. Functional and performance specifications of the project
P3. Block and communications architecture of the IoT system and implementationalternatives
P4. System implementation. Selection of components and platforms
P5. Estimation of planning, costs and business model
P6. Document, presentation and defense of the project

Labs: Prototyping the (original) IoT system
L1. Introduction to programming on a MCU-BLE
L2. Sensor + MCU + Bluetooth dataflow emulation
L3. Android APP Programming I: Bluetooth Low energy Data Acquisition.
L4. Android Programming II: Computation and JSON application to a server.
L5. Cloud application: back-end & front-end
L6. Final presentation

## Activities and Methodology

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|
| Type: Directed | | | |
| Theoretical background & Seminars | 30 | 1.2 | 1, 2 |
| Type: Supervised | | | |
| Project Design & Laboratory (prototyping) | 28 | 1.12 | 2 |
| Type: Autonomous | | | |
| Personal study & work | 90 | 3.6 | 2 |

The learning methodology will combine: master classes, activities in tutored sessions,project based-learning and use cases, debates and other collaborative activities; andlaboratory sessions.

Attendance will be mandatory for the Design of the IoT project and Laboratory sessionsthat will be done in groups of 2 or 3 people.

The laboratory sessions will use a supervised format (not guided) to offer greater autonomyto students and a more personalized support.

This course will use UAB's virtual campus at https://cv.uab.cat.

Note: Within the schedule set by the centre or degree programme, 15 minutes ofone class will be reserved for students to evaluate their lecturers and their courses ormodules through questionnaires.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

## Assessment

## Continous Assessment Activities

| Title | Weighting | Hours | ECTS | Learning Outcomes |
|---|---|---|---|---|
| Evaluation of activities developed in tutorized sessions (laboratories) | 40% | 0 | 0 | 1, 2 |
| Individual activities (e.g. exercices) | 20% | 0 | 0 | 2 |
| Report and defence of the design project | 40% | 2 | 0.08 | 1, 2 |

This course does not provide for the single assessment system (No exam).

The evaluation of the course will follow the rules of the continuous evaluation and the finalgrade for the course, is calculated in the following way:
A - 20% from the mark obtained by the student through the evaluation of activities (i.e.exercises). When an evaluation activity is scheduled, the evaluation indicators will bereported and its weight in this qualification.
B - 40% from the mark obtained through the evaluation of the IoT design project.
C - 40% from the mark obtained by the student of the laboratory work and reports. It isnecessary to exceed 5 (out of 10) in this item to pass the subject.

All activities will require delivering report through the virtual campus.
Type A activities will be proposed along the course for groups of lectures.
Type B activities, will require delivering partial reports of a global IoT project documentevery 2 weeks.
Type C activities, will require delivering two partial reports (one by mid semester and a 2ndone at the end).

To obtain MH it will be necessary that the students have an overall qualification higher than9 with the limitations of the UAB (1MH/20students). As a reference criterion, they will beassigned in descending order.

A final weighted average mark not lower than 50% is sufficient to pass the course, providedthat a score over one third of the range is attained in every one of the Marks for items Band C. If not reached, the mark will be 4.0.

Plagiarism will not be tolerated. All students involved in a plagiarism activity will be failedautomatically. A final mark no higher than 30% will be assigned.

Open source code or available libraries can be used but they must be referred in thecorresponding reports.

An student not having achieved a sufficient final weighted average mark, may opt to applyfor remedial activities (individual work or additional synthesis examination) the subjectunder the following conditions:
- the student must have participated in the laboratory activities and design project, and
- the student must have a final weighted average higher than 30%, and
- the student must not have failed any activity due to plagiarism.

The student will receive a grade of "Not Evaluable" if:
- the student has not been able to be evaluated in the laboratory activities due to notattendance or not deliver the corresponding reports without justified cause.
- the student has not carried out a minimum of 50% of the activities proposed.
- the student has not done the design project.

For each assessment activity, the student or the group will be given the correspondingcomments. Students can make complaints about the grade of the activity, which will beevaluated by the teaching staff responsible for the subject.

Repeating students will be able to "save" their grade in laboratory activity.

## Bibliography

C. Pfister. Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud (Make:Projects) . O'Really. 2011.
A. McEwen, H. Cassimally. Designing the Internet of Things.2014. Willey.
A. Bahga, V. Madisetti. Internet of Things: A Hands-on Approach. VTP. 2015.
S. Greengard, The Internet of Things. The MIT Press Essential Knowledge series.
V. Zimmer. Development Best Practices for the Internet of Things.
A. Bassi, M. Bauer, M. Fiedler, T. Kramp, R. van Kranenburg, S. Lange, S. Meissner. (Eds) Enabling Things to Talk -Designing IoT solutions with the IoT Architectural Reference Model. Springer.
J. Olenewa, Guide to Wireless Communications, 3rd Edition, Course Technology, 2014.
P. Raj and A. C. Raman, The Internet of Things: Enabling Technologies, Platforms and Use Cases, CRC Press 2017.
H. Geng (Ed.), Internet of the Things and Data Analytics Handbook, Wiley 2017.
Y. Noergaard, "Embedded Systems Architecture" 2nd Edition, 2012, Elsevier
K. Benzekki, Softwaredefined networking (SDN): a survey, 2017, https://doi.org/10.1002/sec.1737
https://blogs.cisco.com/innovation/barcelona-fog-computing-poc
https://aws.amazon.com/
A.K. Bourke et al. Evaluation of waist-mounted tri-axial accelerometer based fall-detection algorithms during scriptedand continuous unscripted activities, Journal of Biomechanics, Volume 43, Issue 15, 2010, pp. 3051-3057
N. Jia. Detecting Human Falls with a 3-Axis Digital Accelerometer. Analog Devices.
http://www.analog.com/en/analog-dialogue/articles/detecting-falls-3-axis-digital-accelerometer.html

## Software

Students will use the SoC-BLE from Nordic Semiconductors as a device; theAndroid smartphone as Edge; and any server cloud option (selected by the students) with front-end i back-end.

## Language list

| Name | Group | Language | Semester | Turn |
|---|---|---|---|---|
| (PLAB) Practical laboratories | 418 | English | first semester | morning-mixed |
| (PLAB) Practical laboratories | 419 | English | first semester | morning-mixed |
| (TE) Theory | 418 | English | first semester | morning-mixed |