R.7.1.-3. Set of classes adapted to the online remote teaching for 4 disciplines

for the Project Education 4.0: Living Labs for the Students of the Future (LLSF)

Contract number 2021-1-RO01-KA220-HED-000032176

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List of participants

Participant No *	Participant organisation name	Acronym	Country
1 (Coordinator)	National University of Science and Technology POLITEHNICA Bucharest	UNSTPB	RO
2	Universidade NOVA de Lisboa	NOVA	PT
3	Universita Politecnica delle Marche	UPM	IT
4	Universidad Nacional de Education a Distancia	UNED	ES
5	Tel Aviv University	TAU	IL

Revision history:

Rev	Date	Partner	Description	Name
1	22/Jan/2025	TAU	First draft	Tal Soffer

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Contents

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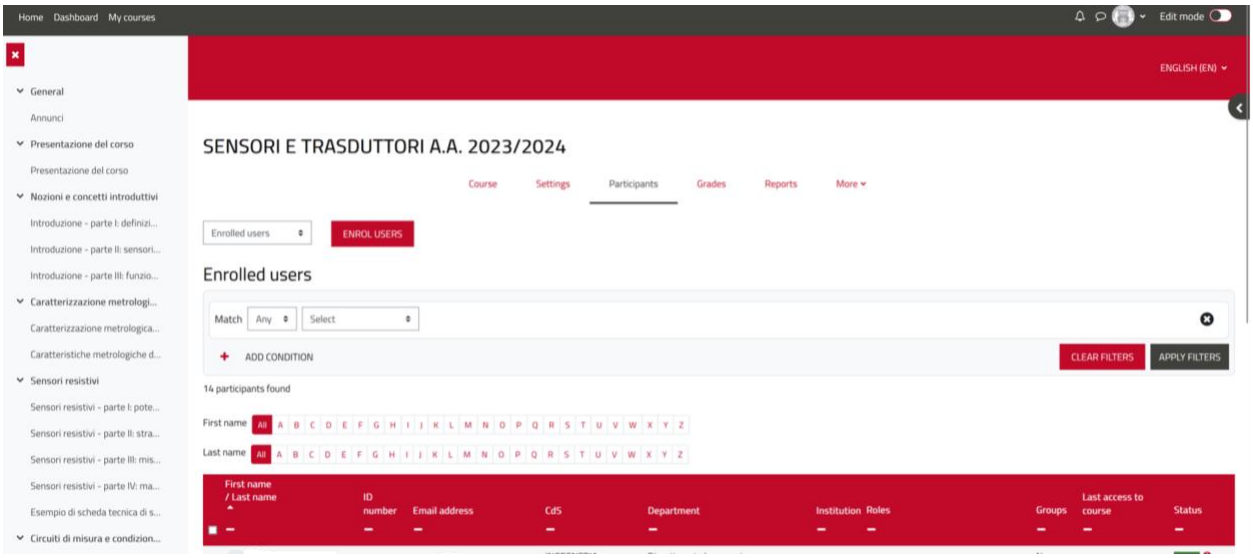
The identified disciplines by **UnivPM** are "**Sensors, Instrumentation and Measurements Lab**" and "**Audio Digital Signal Processing**".

Sensors, Instrumentation and Measurements Lab



Sensors/Transducers

- A transducer is a device that operates a transformation of the physical quantity it has as input to return a physical quantity of a different type as output.
  - A signal having a certain physical nature is converted into a corresponding signal, of a different physical nature: the input and output quantities are different
  - *Energy converter*
- A **sensor** is a particular transducer that is in direct interaction with the measured system
  - It is a device that converts an input quantity of *any nature or a stimulus* into an ***electrical quantity***
  - Most measurement systems use electrical signals and therefore rely on sensors

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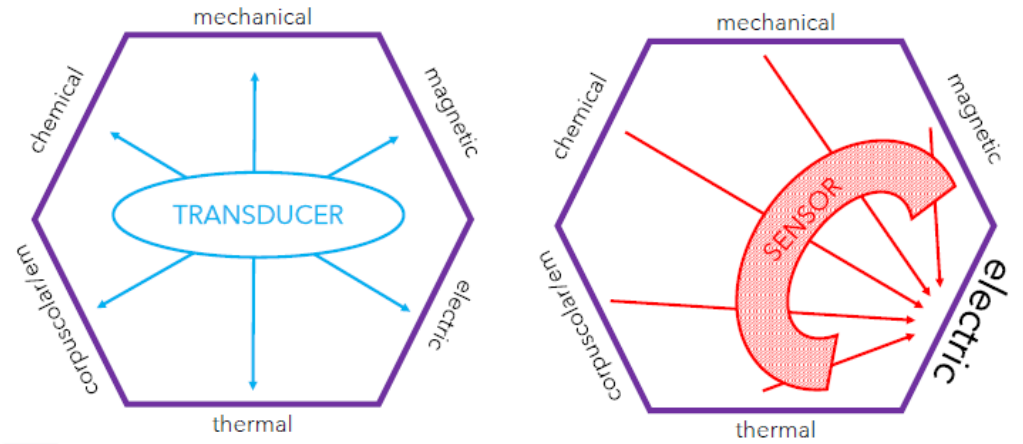
Sensors/Transducers



Sensors and the measurement/control process

- Sensors enable measurement and control processes because they provide electrical signals which in some of their properties "contain" the information relating to the measurand
- Electronic circuits process these signals to extract information, so sensors are the basis of measurement systems
- The purpose of a measurement system is to objectively and empirically attribute a value to a property or quality of an object, or to an event, to describe it

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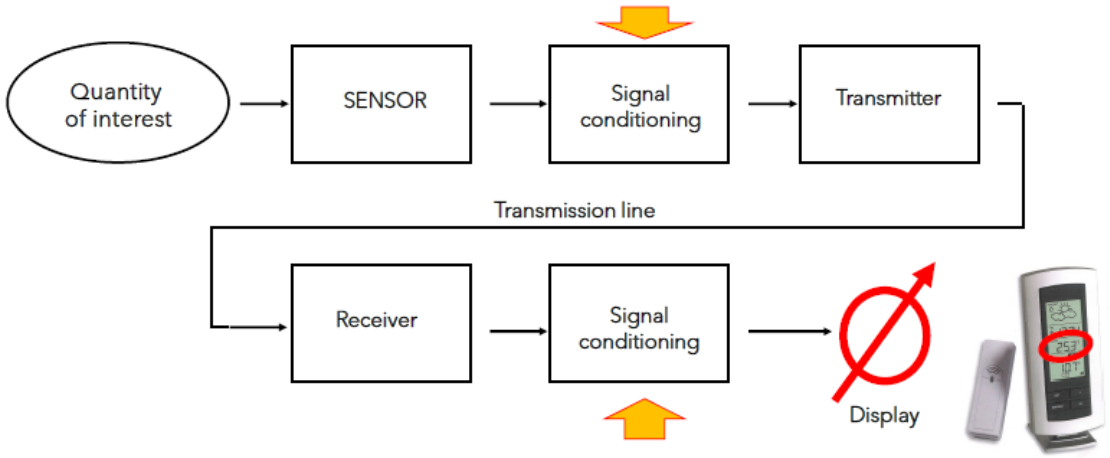
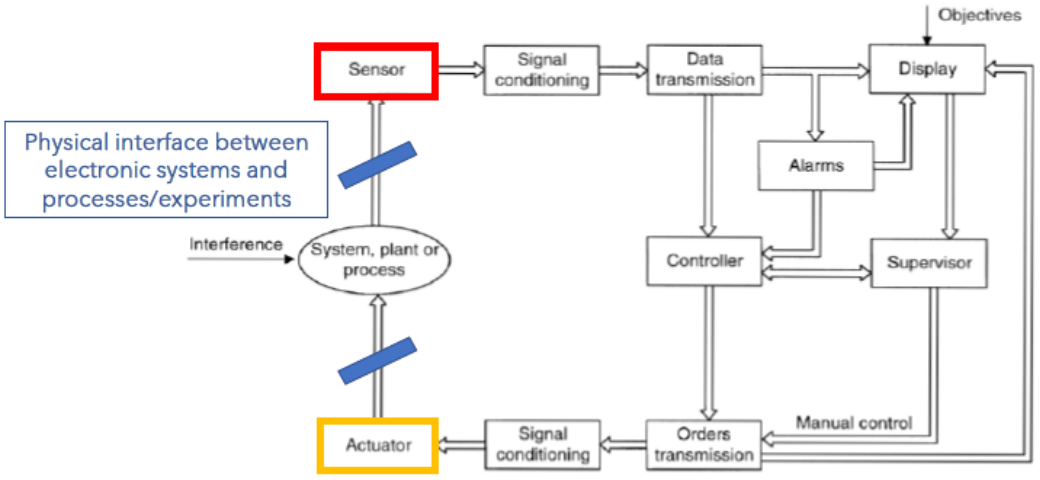
Sensors and the measurement chain



Sensors and the control process



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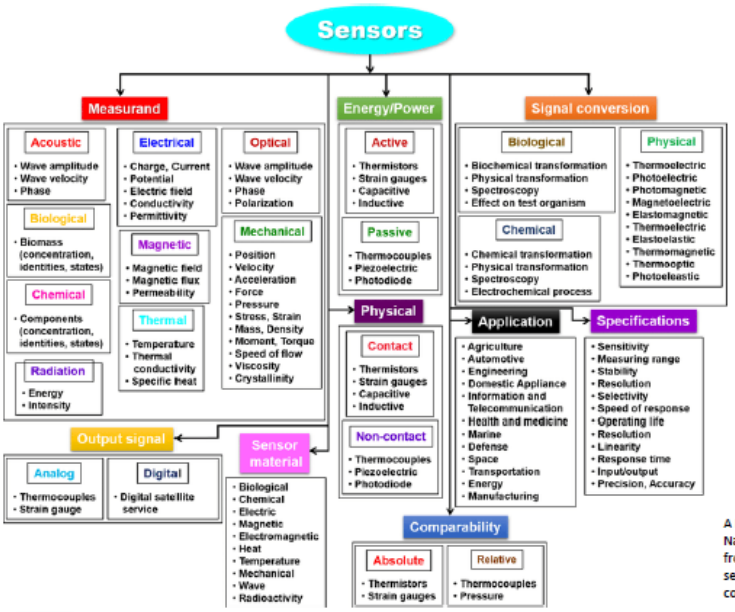

A Review on Biosensors and Recent Development of Nanostructured Materials-Enabled Biosensors. Available from: https://www.researchgate.net/figure/Classification-of-sensors-based-on-measurand-energy-power-physical-contact-signal_fig1_349070662 [accessed 19 Sep, 2023]

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Self-generating sensors: the piezoelectric effect

- Self-generating sensors yield an electric signal from a measurand without requiring any electric supply
- They offer alternative methods for measuring many common quantities, in particular: temperature, force, pressure, and acceleration
- Furthermore, because they are based on **reversible effects**, these sensors can be used as **actuators** to obtain non-electric outputs from electric signals
- The **piezoelectric effect** is the appearance of an electric polarization in a material that strains under stress
- It is a reversible effect: therefore, when applying an electric voltage between two sides of a piezoelectric material, it strains.

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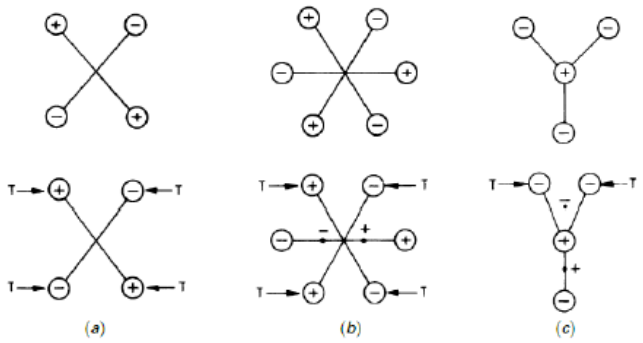
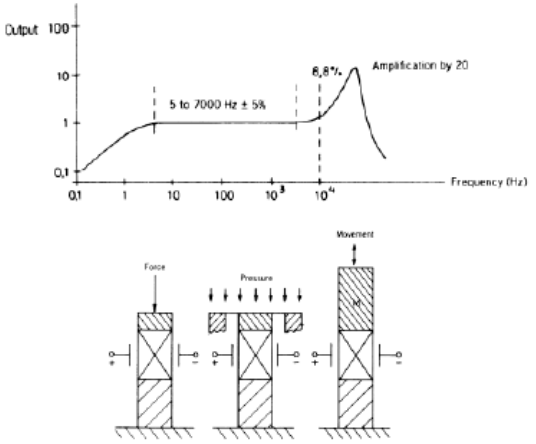
Self-generating sensors: the piezoelectric effect



Effects of a mechanical stress on different molecules depending on their symmetry : (*a*) When there is central symmetry, no electric polarization arises. (*b*) Polarization parallel to the effort. (*c*) Polarization perpendicular to the effort.

Self-generating sensors: the piezoelectric effect

Piezoelectric sensors show a high resonant peak in their frequency response. This is because when a dynamic force is applied to them, the only damping source is the internal friction in the material. Thus, **we must always work at frequencies well below the mechanical resonant frequency**, and the sensor output must be low-pass filtered to prevent amplifier saturation.



Force, pressure, and movement sensors based on piezoelectric elements

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Piezoelectric sensors: applications

- Piezoelectric pressure sensors are used for monitoring internal combustion engines and in hydrophones. Because they **lack DC response**, they do not suit load cells
- Piezoelectric sensors with integral electronics are more reliable than sensors with external electronics because the connector is less critical – this is important in shock and vibrations monitoring
    - Piezoelectric accelerometers offer wider frequency bandwidth (0.1 Hz to 30 kHz), much lower power consumption, and higher shock survivability than micromachined accelerometers (MEMS). However, they are inferior for static or very low frequency measurements
    - They are applied to machine monitoring, shock detection in shipment monitoring, impact detection, or drop testing, vehicle dynamics assessment and control, and structural dynamics analysis to detect response to load, fatigue, and resonance

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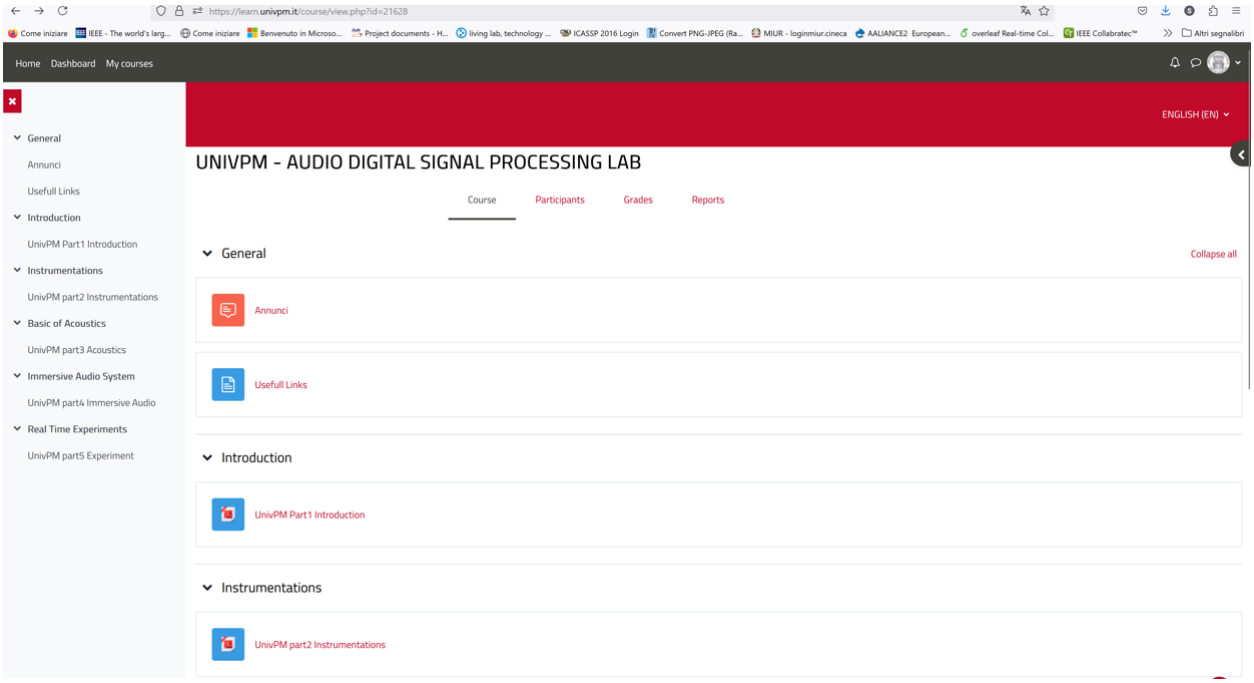
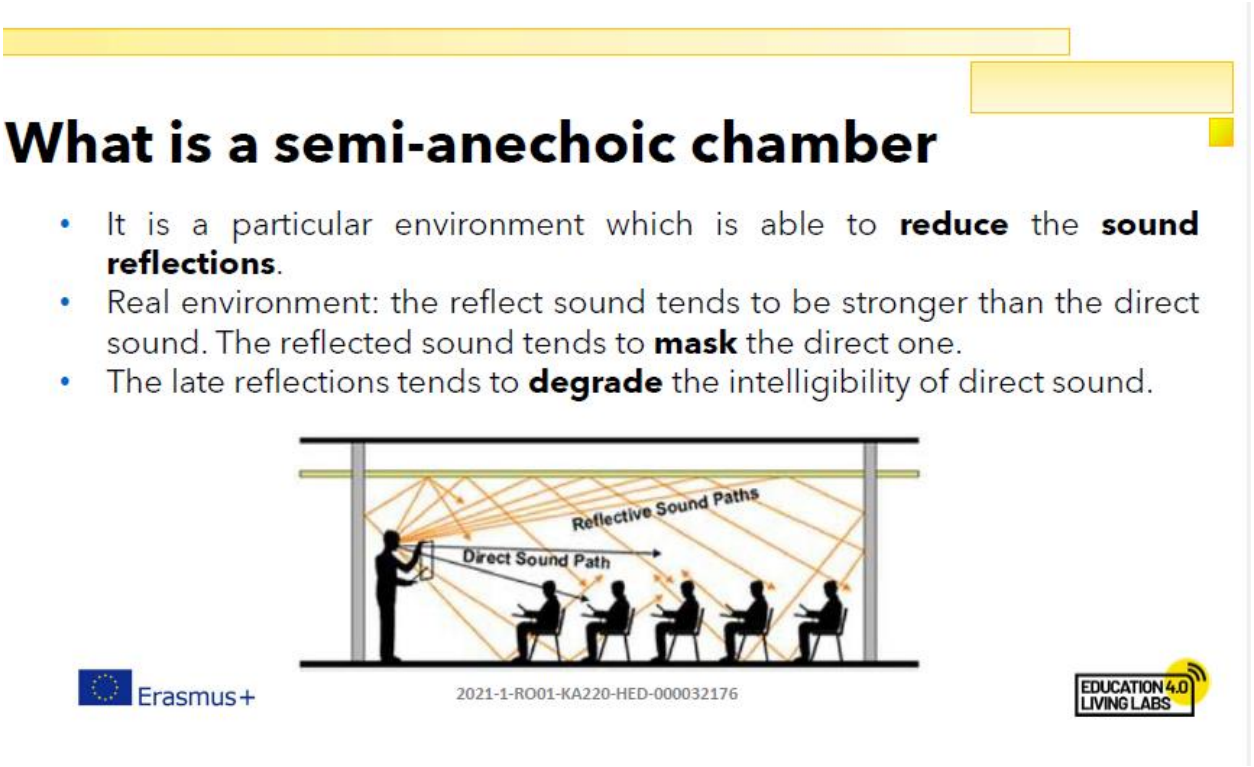
Audio Digital Signal Processing





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Instruments

- The chamber is certified to make measurements according to **ISO regulations**.
- Acoustic benchmarking activities, development of products, acoustic insulation of machines.
- Advanced instrumentations for measurements ad acquisitions.

Experiments

- Many experimental setup can be prepared inside the chamber.
- The experiments changes during the year according to the research activities.
- The chamber properties allows to make measurements in a very silent environment without any reverberations.
- It is possible to validate DSP algorithms in a controlled environment, among other active noise control and acoustic beamforming algorithms are tested.

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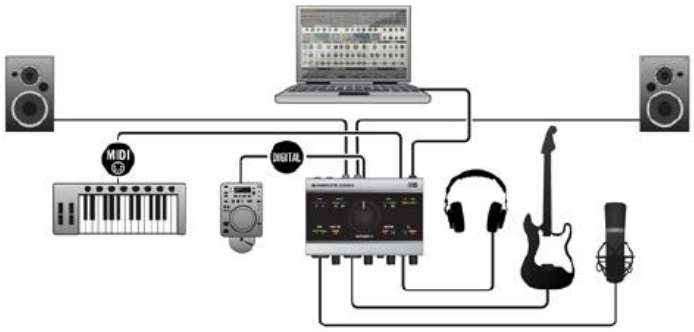
Audio devices for sound generation and acquisition

- Acquisition and reproduction chain:



Soundcards

- Many different types
- Based on specific drivers (i.e., ASIO) for a low latency connections

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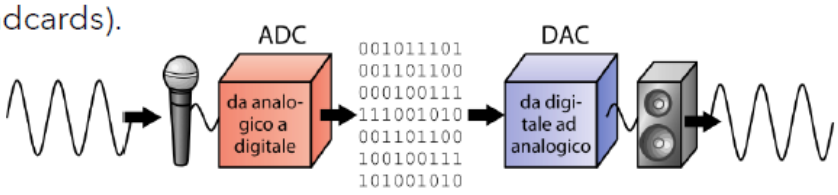
Multichannel systems

- Used when a certified measurement is required

Microphones

- Every microphone has a precise **purpose**: voice, instruments, measurements.
- What is a microphone ?
  - It's a sensor which is able to transform a sound wave into an electric signal.
  - The signal will be then processed by something else (e.g., soundcards).



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Binaural mannequin

- It is a stereophonic binaural microphone, it is used to simulate the human hearing on a standard head.
- It has the size of a medium human adult.
- Is equipped with an auditory canal and an eardrum to simulate a real ear.
- The auricles can be replaced easily.

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SPL meter

- The SPL meter allow for the measurement of the sound pressure level.
- Required to make measurements of noise leve
- Can give information both on the time and frequency domain.

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Immersive Audio System

Binaural Technology

- The 3-D experience that is reproduced by this technique includes more than just the direct arrival of the source sound.
- All aspects of the room acoustics are contained in this binaural recording, including the direction of arrival of early reflections and the fine details of the reverberant tail of the room response.
- The HRTF filtering is achieved by simply convolving the dry audio signal with the pair of HRTF responses (one HRTF filter for each channel of the headphone):

$$y_L(n) = \sum_{k=0}^{N-1} HRTF_L(k) \cdot x(n-k)$$

$$y_R(n) = \sum_{k=0}^{N-1} HRTF_R(k) \cdot x(n-k)$$

where x(n) is the input audio stream (monoaural)

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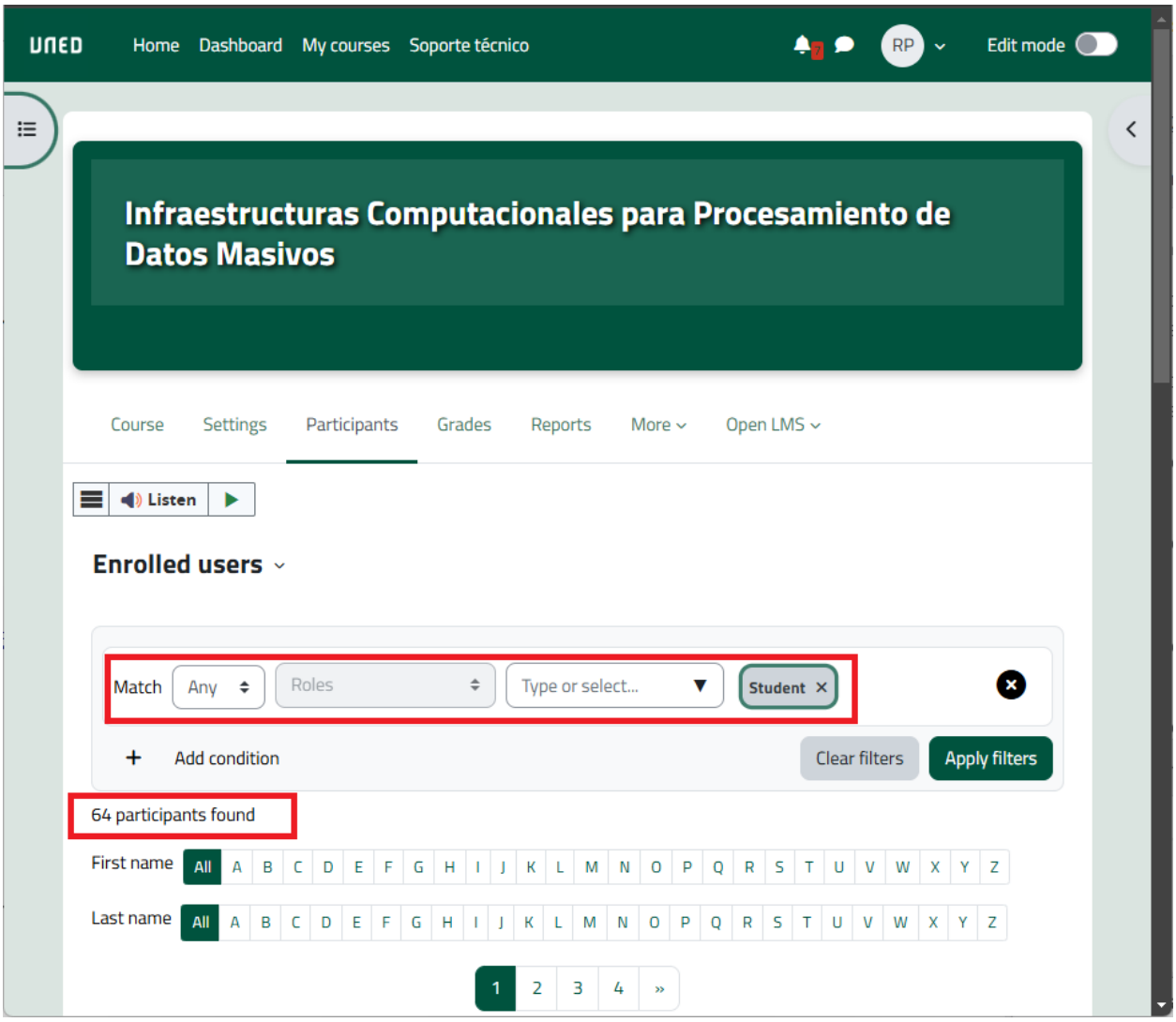
The identified disciplines by **UNED** are "**Computational Infrastructures for Massive Data Processing**".

"Computational Infrastructures for Big Data Processing" (Code 31110056): 2024-25

Master's Degree in Data Science and Engineering



PRESENTATION AND CONTEXTUALIZATION

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Subject Name: Computational Infrastructures for Big Data Processing
Code: 31110056
Session: 2024/2025
Degree in Which It Is Offered: Master's Degree in Data Science and Engineering
Type: Contents
Credits Number: 6
Hours: 150
Period: Semester 1
Languages Available: Spanish

Presentation

Working with big data requires the use of computational infrastructures specifically designed for it. These infrastructures differ from traditional ones in several aspects. Firstly, it is necessary to combine the computing power of many computers, creating what is known as a computer cluster. Additionally, programming paradigms that can leverage the computing power of the cluster in a simple way for the developer are needed. Both aspects can be developed using cloud service providers. This course introduces some of the most important technologies that enable the deployment of infrastructures for big data processing. Within this Master's program, it is important to acquire a solid understanding of the most commonly used tools in this context, as they are essential for handling both structured and unstructured big data.

Contextualization

The course "Computational Infrastructures for Big Data Processing" is a 6 ECTS credit mandatory course offered in the first semester of the Master's program in Data Science and Engineering. It belongs to the subject area "Infrastructures and Systems for Data Management," which also includes courses like "Management/Storage of Unstructured Information" and "Data Management Security." Additionally, it is related to other courses available in the same Master's program, such as "Programming in Data Environment" and "Data Visualization."

REQUIREMENTS AND/OR RECOMMENDATIONS TO TAKE THE SUBJECT

It is recommended that those interested in pursuing the Master's program have a sufficient level of reading in English to understand technical content in that language. Much of the bibliography, as well as the resources provided to students in the virtual course, may be available only in English due to the novelty of some of the content proposed for the course.

Since different types of deployments and/or technologies will be covered, it is necessary for students to have solid knowledge of operating systems and networks, at the level of command management and file manipulation (especially Linux).

It is recommended that students have powerful computers for practical work, with at least 16GB of memory. If they use less powerful computers, they may experience slower performance.

The use of free software will be encouraged whenever possible for the completion of activities and practical work.

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TEACHING STAFF

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Departament	SISTEMAS DE COMUNICACIÓN Y CONTROL

OFFICE HOURS

Student Tutoring Student tutoring will primarily take place through the forums on the platform, although other means such as interactive chats, instant messaging services, and email may also be used occasionally. Additionally, for personal matters that do not affect the rest of the students, consultations in person or by phone are also planned.

Monitoring Learning Progress Learning progress will be monitored by reviewing student participation in the various discussion forums, contributions of new material, and the timely submission of the different practical assignments planned throughout the course.

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Contacting the Teaching Team If it is necessary to contact the Teaching Team through means other than the virtual course, email will be preferred. Telephone consultations and personal interviews can also be conducted during the established hours shown in the following table.

Professor	Time	Email	Phone
Agustín C. Caminero Herráez	Monday 10h-14h	accaminero@scc.uned.es	91 398 9468
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Salvador Ros Muñoz	Monday and Tuesday 16h-18h.	sros@scc.uned.es	91 398 7205

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COMPETENCIES THAT THE STUDENT ACQUIRES

Basic Competencies

CB6 - Possess and understand knowledge that provides a foundation or opportunity to be original in the development and/or application of ideas, often in a research context.

CB7 - Students should know how to apply the knowledge acquired and their problem-solving skills in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.

CB8 - Students should be able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments.

CB9 - Students should know how to communicate their conclusions and the knowledge and reasons that support them to specialized and non-specialized audiences in a clear and unambiguous manner.

CB10 - Students should possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

General Competencies

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CG3 - Develop systems for the management/storage/processing of large volumes of data in an efficient and secure manner, taking into account existing regulations/legislation.

CG5 - Use the skills of a data scientist and/or data engineer in multidisciplinary work environments and be able to distinguish/organize the different activities of the roles in that environment.

Transversal Competencies

CT1 - Be capable of addressing and developing innovative projects in scientific, technological, and multidisciplinary environments.

CT2 - Be capable of making decisions and formulating judgments based on objective criteria (available experimental, scientific, or simulation data).

Specific Competencies

CE2 - Develop applications/services/scripts oriented towards data analytics and analyze the use of different libraries for the development and implementation of numerical methods, algorithms, and models associated with data.

CE8 - Design and use big data management models based on available tools on clusters and in the cloud.

CE9 - Identify and use techniques for developing data manipulation algorithms in big data management environments.

LEARNING RESULTS

The intended learning outcomes for this course are as follows:

- Distinguish between the main tools for data injection, programming, and storage of big data, both in batch and streaming.
- Design programs for big data analysis using the appropriate tools for data injection, analysis, and storage.
- Describe the most important characteristics of the main Big Data programming architectures and their deployment methods, both locally and in the cloud.
- Identify and select different configuration options to optimize Big Data infrastructures.

CONTENTS

Module 1: Parallel Processing Ecosystem for Big Data: Apache Hadoop

Contents:

- **Topic 1**: Introduction to Big Data and Hadoop.
- **Topic 2**: MapReduce Programming.

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- **Topic 3**: MapReduce Programming with High-Level Languages: Hive and Pig.
- **Topic 4**: Serialization/Deserialization and Data Injection/Extraction Tools.

This module presents the tools of the Apache Hadoop ecosystem, which cover a wide range of functionalities, from managing distributed parallel infrastructures with YARN, fault-tolerant data storage with HDFS, parallel distributed programming using the MapReduce paradigm, both directly and through high-level programming tools like Hive or Pig, to data ingestion and serialization.

The fundamental objective is to help students understand the processing capabilities of Apache Hadoop, as well as the wide variety of tools that make up its ecosystem, which cover many functionalities. The skills acquired during the course will allow students to integrate this platform into different environments, including those available in the Cloud.

Although a variety of technologies are covered, the aim is not to gain deep knowledge of these technologies but rather to understand their most important possibilities. The most complex content of the topic is MapReduce programming, as it involves a way of structuring code that differs from other parallel programming paradigms.

For their study, students will have access to various video lessons that will help them acquire these basic concepts through the learning platform. These video lessons are complemented by other interesting references available for free to students through the O'Reilly digital library (in English).

To verify the acquisition of knowledge from the module, students can complete a self-assessment questionnaire available on the learning platform. Additionally, they must complete a mandatory assignment that involves developing a big data processing solution using technologies from the Hadoop ecosystem.

Module 2: In-Memory Parallel Processing: Apache Spark

Contents:

- **Topic 1**: Introduction and Installation of Apache Spark
- **Topic 2**: Application Programming in Spark
- **Topic 3**: Spark Libraries/Components
- **Topic 4**: Spark Configuration, Monitoring, and Optimization

This module introduces the Apache Spark tool, which allows the development of in-memory parallel applications. It covers the core of Spark and some of its libraries, such as MLlib for machine learning and GraphX for graph-based processing. It also presents tools for monitoring the performance of the Spark cluster.

The fundamental objective is to help students understand the processing capabilities of Spark and how to deploy analytical solutions based on this technology. The skills acquired during the course will allow students to integrate this platform into different environments, including those available in the Cloud.

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The content of the module is not highly difficult, although studying libraries like GraphX or Machine Learning may be more challenging (especially if the student does not have an adequate mathematical background).

For their study, students will have access to various video lessons that will help them acquire these basic concepts through the learning platform. These video lessons are complemented by other interesting references available for free to students through the O'Reilly digital library (in English).

To verify the acquisition of knowledge from the module, students can complete a self-assessment questionnaire available on the learning platform. Additionally, they must complete a mandatory assignment that involves developing an analytical solution using Spark.

Module 3: Real-Time Data Management (Streaming)

Contents:

- **Topic 1**: Introduction to Stream Processing Architectures: Lambda and Kappa
- **Topic 2**: Technological Components for Event Acquisition and Transmission/Distribution: Kafka
- **Topic 3**: Stream Processing: Spark Streaming

This module presents tools for programming real-time (streaming) applications. It explains two of the most widely used architectures for stream data processing, Lambda and Kappa. To implement these architectures, technological components for event acquisition and transmission (Kafka) and for stream processing (Spark Streaming) are presented.

In the virtual course, the teaching team will publish materials such as slides, links to the bibliography, practical exercises, self-assessment questionnaires, and video lessons to cover these contents.

Module 4: Managed Cloud Services for Big Data Processing

Contents:

- **Topic 1**: Cloud Solutions for Data Storage Management.
- **Topic 2**: Cloud Solutions for Data Processing.
- **Topic 3**: Cloud Solutions for Implementing Streaming Architectures.

This module presents various proposals for managed services based on cloud providers to cover functionalities such as storage and data processing in batch and streaming. Specifically, the solutions of these providers for managed services like Hadoop and Spark, as well as the specific streaming solutions provided by these cloud providers, will be covered.

The fundamental objective of the module is to provide students with the critical capacity necessary to identify viable cloud solutions for the infrastructures and tools covered in the previous topics.

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This critical capacity will allow students to adequately choose the most appropriate data analysis solution in managed cloud environments.

The content of the module is very practical and not highly difficult, making it easy to study. These contents are accompanied by self-assessable exercises/tasks that add more practical components to this module.

For their study, students will have access to various video lessons that will help them acquire these basic concepts through the learning platform. These video lessons are complemented by other interesting references available for free to students through the O'Reilly digital library (in English).

To verify the acquisition of knowledge from the module, students can complete a self-assessment questionnaire available on the learning platform. Additionally, they must complete a mandatory assignment that involves implementing an analytical solution using one of the cloud providers studied during the module.

METHODOLOGY

This course has been designed for distance learning. Therefore, the teaching-learning system will be largely based on the independent or autonomous study of the student. To this end, the student will have various materials that will allow for autonomous work and the Study Guide for the course, which includes guidelines for carrying out practical activities. Additionally, through the UNED virtual platform, there will be continuous contact between the teaching team and the students, as well as interaction among the students themselves through the forums, which is very important in non-face-to-face teaching.

The study of this course will be carried out through the materials that the Teaching Team will publish in the virtual course.

The training activities for the study of the course are as follows:

- Content studies (67 hours)
- Tutoring (13 hours)
- Activities on the virtual platform (2 hours)
- Computer practices (58 hours)
- Assignments (10 hours)

Total: 150 hours

The necessary resources for learning are:

- Theoretical-practical materials prepared by the Teaching Team to cover the basic concepts of the syllabus.
- Complementary bibliography. The student can find additional information to complete their training.

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- Virtual Course of the subject, where the student will find:
    - A guide to the subject that provides a detailed description of the proposed work plan.
    - A calendar with the temporal distribution of the topics proposed by the Teaching Team and the deadlines for the theoretical-practical activities that the student must complete for evaluation.
    - Statements of the proposed theoretical-practical activities and a section where the associated deliverables can be submitted.
    - Forums through which the Teaching Team will clarify general doubts and also communicate any news that arises throughout the course. This will be the main means of communication among the various participants in the course.

WORK PLAN

The calculation of hours includes the time devoted to teaching hours, study hours, tutorials, seminars, assignments, internships or projects, as well as those required for the preparation and conduct of examinations and evaluations. On the second screen, instructions on the type of content appear. At the end of the word "learning," it should be followed by a colon: "... include information on the activities necessary for their learning."

Hours

BLOCK Module 1: Parallel Processing Ecosystem for Big Data: Apache Hadoop In this module, the following contents will be covered:

- **Topic 1**: Introduction to Big Data and Hadoop.
- **Topic 2**: MapReduce Programming.
- **Topic 3**: MapReduce Programming with High-Level Languages: Hive and Pig.
- **Topic 4**: Serialization/Deserialization and Data Injection/Extraction Tools.

Duration: Weeks 1 to 6, with the following breakdown:

- **Topic 1**: Week 1.
- **Topic 2**: Weeks 2 and 3.
- **Topic 3**: Weeks 4 and 5.
- **Topic 4**: Week 6.

Activities to be carried out (through the virtual course):

- Study of the materials provided by the Teaching Team through the virtual course: 26 hours.

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- Completion of self-assessment questionnaires published in the virtual course: 1 hour.
- Forum consultation: 6 hours.
- Completion of Laboratory Practice 1 * **: 27 hours (Weeks 3 to 6).
- The dates for the laboratory practice will be published in the virtual course well in advance. A minimum score is required to pass the course (details are in the evaluation section of this guide).

** The grade for the laboratory practice is retained for the extraordinary call. Additionally, another submission period will be opened for that call.

Total: 60 hours

BLOCK Module 2: In-Memory Parallel Processing: Apache Spark In this module, the following contents will be covered:

- **Topic 1**: Introduction and Installation of Apache Spark.
- **Topic 2**: Application Programming in Spark.
- **Topic 3**: Spark Libraries/Components.
- **Topic 4**: Spark Configuration, Monitoring, and Optimization.

Duration: Weeks 7 to 9, with the following breakdown:

- **Topic 1**: Week 7.
- **Topic 2**: Weeks 7 and 8.
- **Topics 3 and 4**: Week 8.

Activities to be carried out (through the virtual course):

- Study of the materials provided by the Teaching Team through the virtual course: 15 hours.
- Completion of self-assessment questionnaires published in the virtual course: 1 hour.
- Forum consultation: 2 hours.
- Completion of Laboratory Practice 2 * **: 25 hours (Weeks 8, 9, and 10).
- The dates for the laboratory practice will be published in the virtual course well in advance. A minimum score is required to pass the course (details are in the evaluation section of this guide).

** The grade for the laboratory practice is retained for the extraordinary call. Additionally, another submission period will be opened for that call.

Total: 43 hours

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BLOCK Module 3: Real-Time Data Management (Streaming) In this module, the following contents will be covered:

- **Topic 1**: Introduction to Stream Processing Architectures: Lambda and Kappa.
- **Topic 2**: Technological Components for Event Acquisition and Transmission/Distribution: Kafka.
- **Topic 3**: Stream Processing: Spark Streaming.

Duration: Weeks 10 and 11, with the following breakdown:

- **Topic 1**: Week 10.
- **Topic 2**: Weeks 10 and 11.
- **Topic 3**: Week 11.

Activities to be carried out (through the virtual course):

- Study of the materials provided by the Teaching Team through the virtual course: 16 hours.
- Completion of self-assessment questionnaires published in the virtual course: 1 hour.
- Forum consultation: 2 hours.

Total: 19 hours

BLOCK Module 4: Managed Cloud Services for Big Data Processing In this module, the following contents will be covered:

- **Topic 1**: Cloud Solutions for Data Storage Management.
- **Topic 2**: Cloud Solutions for Data Processing.
- **Topic 3**: Cloud Solutions for Implementing Streaming Architectures.

Duration: Weeks 12 and 13.

Activities to be carried out (through the virtual course):

- Study of the materials provided by the Teaching Team through the virtual course: 10 hours.
- Completion of self-assessment questionnaires published in the virtual course: 1 hour.
- Forum consultation: 1 hour.
- Completion of Laboratory Practice 3 * **: 14 hours (Weeks 12 and 13).
- The dates for the laboratory practice will be published in the virtual course well in advance. A minimum score is required to pass the course (details are in the evaluation section of this guide).

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** The grade for the laboratory practice is retained for the extraordinary call. Additionally, another submission period will be opened for that call.

Total: 26 hours

Face-to-Face Exam: 2 hours

Total Hours ECTS introduced here: 150 **Total Hours ECTS for the course**: 150.0

ASSESSMENT SYSTEM

Onsite Test

Type of Exam: Multiple-choice test
Quiz Questions: 20
Duration of the Exam:
Material Allowed in the Exam: None

Assessment Criteria
% Concerning the Final Grade: 40%
Minimum Grade (Not Including Continuous Assessment): 4
Maximum Grade (Not Including Continuous Assessment): 4
Minimum Grade (Including Continuous Assessment): 4

Comments

Characteristics of the In-Person Test and/or the Work
Requires Presence: No
Description:
The student must complete three laboratory practices (practical assignments) associated with three of the four modules that make up the course. The three practices are weighted with 60% of the final grade:

- **Laboratory Practice 1**: The student must develop a solution involving the processing of a dataset using both MapReduce and a high-level programming tool.
- **Laboratory Practice 2**: The student must develop an analytical solution using Spark and one of the libraries explained in the module: GraphX or MLlib (machine learning).
- **Laboratory Practice 3**: The student must use a cloud provider analyzed in the module to deploy a big data processing solution in the cloud.

Assessment Criteria:
The teaching team will publish a guide for the completion of the practices, specifying the evaluation criteria. It is mandatory to submit all three laboratory practices. Each practice will be evaluated on a scale of 10 points, and a minimum average grade of 4 out of 10 is required to pass the course.

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Weighting of the In-Person Test and/or the Assignments in the Final Grade:

- **Laboratory Practice 1 (Module 1)**: 20% of the grade.
- **Laboratory Practice 2 (Module 2)**: 20% of the grade.
- **Laboratory Practice 3 (Module 4)**: 20% of the grade.

Approximate Submission Date:

- **Practice 1**: November 20
- **Practice 2**: January 10
- **Practice 3**: January 25

Comments:
Practices can also be submitted in the extraordinary call, with the date indicated by the teaching team. If the practices are passed but the exam is not, the practice grades will be retained for the extraordinary call in September of the current course.

Continuous Assessment Test (PEC)
PEC?: No
Description:
Assessment Criteria:
Weighting of the PEC in the Final Grade:
Approximate Submission Date:
Comments:

Other Gradeable Activities
Are There Other Evaluable Activities?: No
Description:
Assessment Criteria:
Weighting in the Final Grade:
Approximate Submission Date:
Comments:

How to Obtain the Final Grade?
The final grade is calculated with the following formula:

Final Grade = 40% NE + 60% PS

where NE is the exam grade (from 0 to 10) and PS is the grade of the laboratory practices (each graded from 0 to 10).

The following observations should be taken into account:

- If at least 40% of the total individual score is not obtained in the in-person exam or in each laboratory practice (individually), the student will fail.

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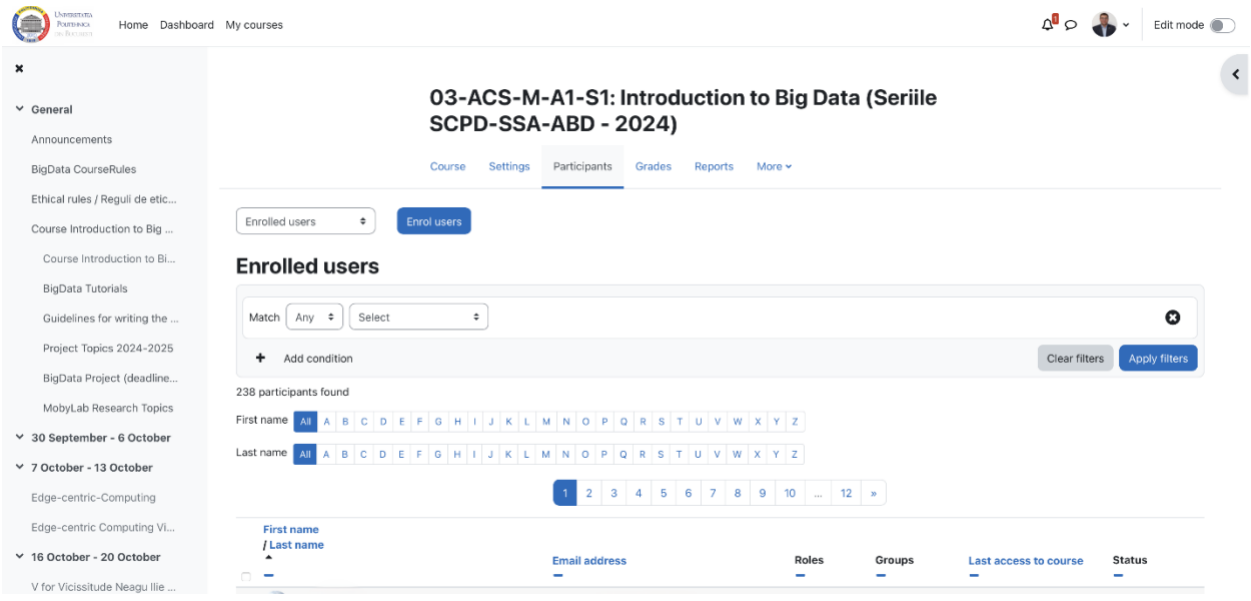
- Otherwise (if more than 40% of the total score is obtained for the exam and each mandatory practice), the final grade will be calculated by summing the different evaluation tests weighted with the percentages described above.
- Students will pass the course if they achieve at least 5 points in the final grade calculated with the defined weightings above.

UPB (P1) aims to set up within the digital learning environment a virtual infrastructure that will allow for remote teaching of ICT disciplines, from Big Data / Cloud concepts, to mobile computing and Internet of Things. The disciplines identified by UPB are **Biga Data** and **Cloud Computing.**

BigData



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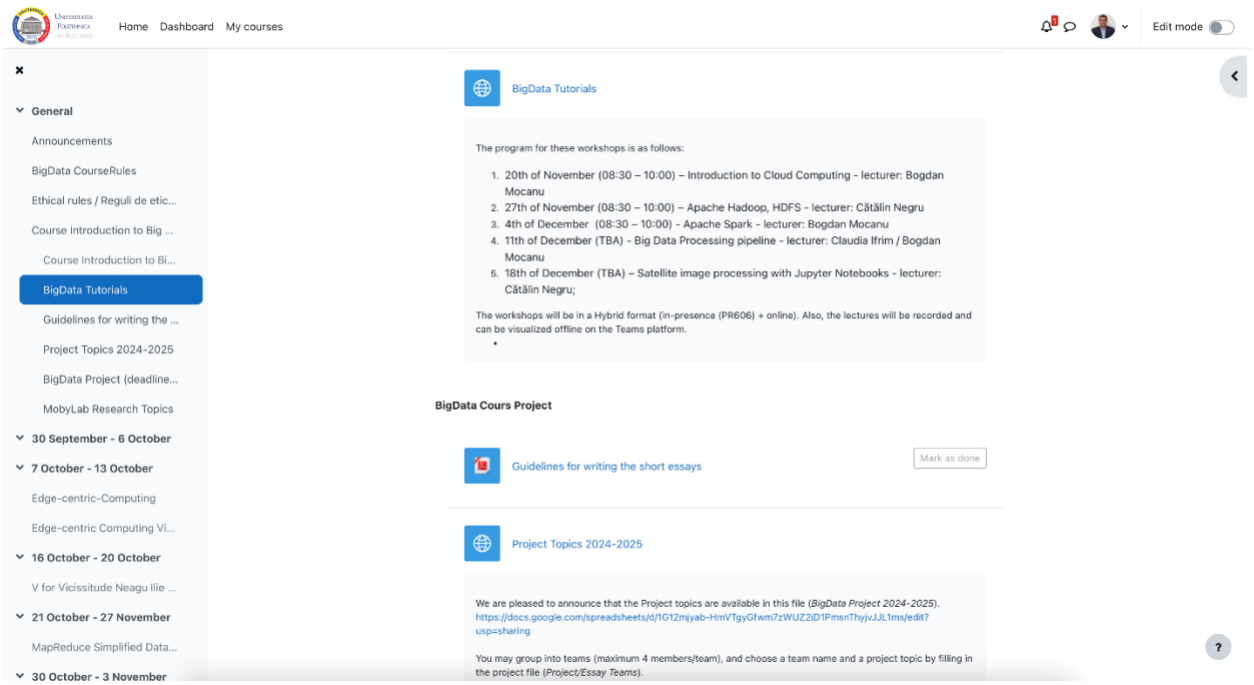

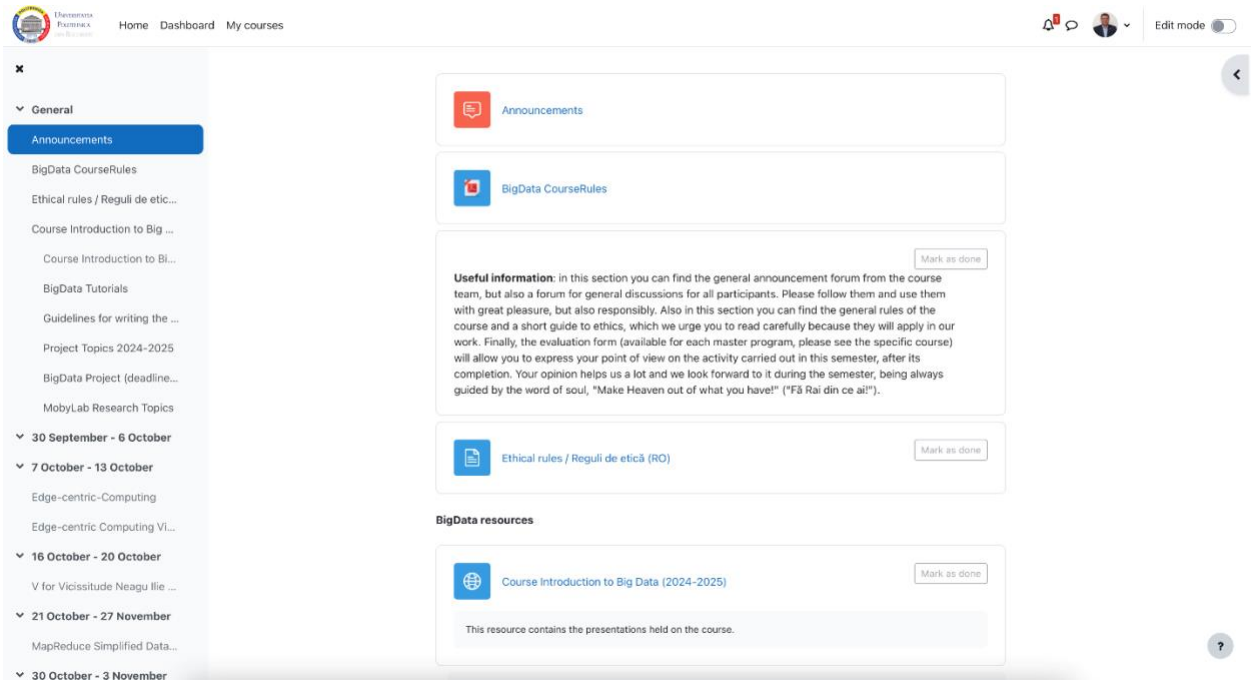

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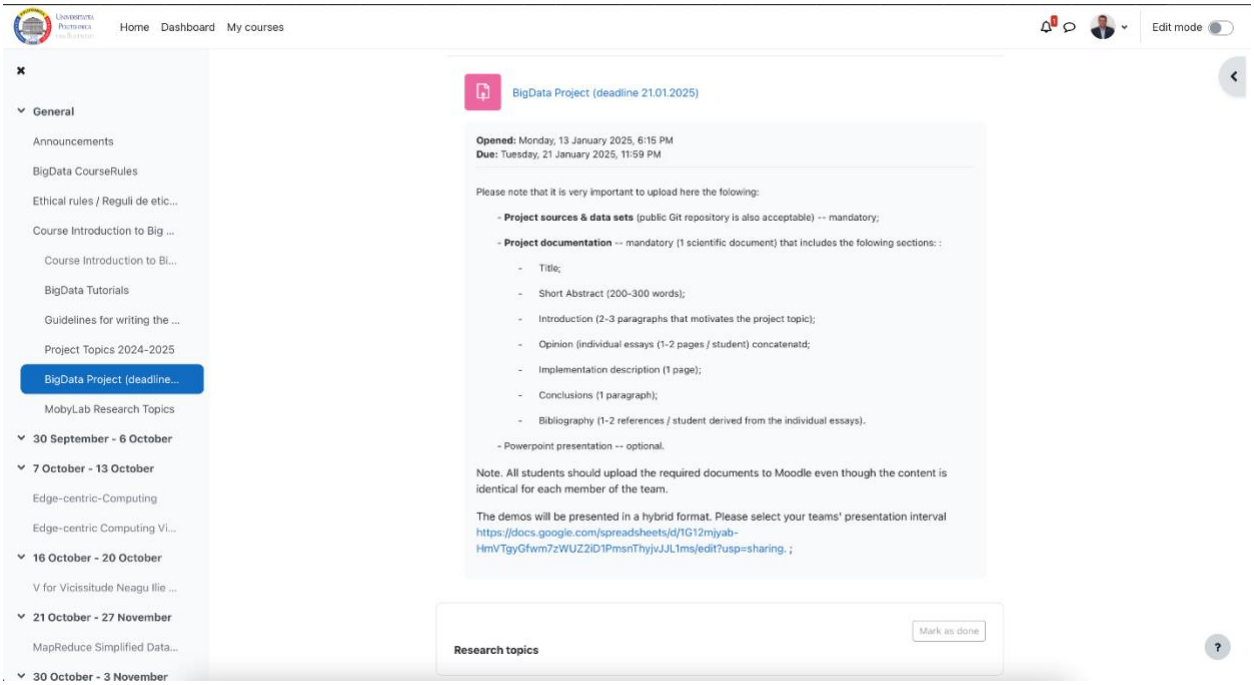

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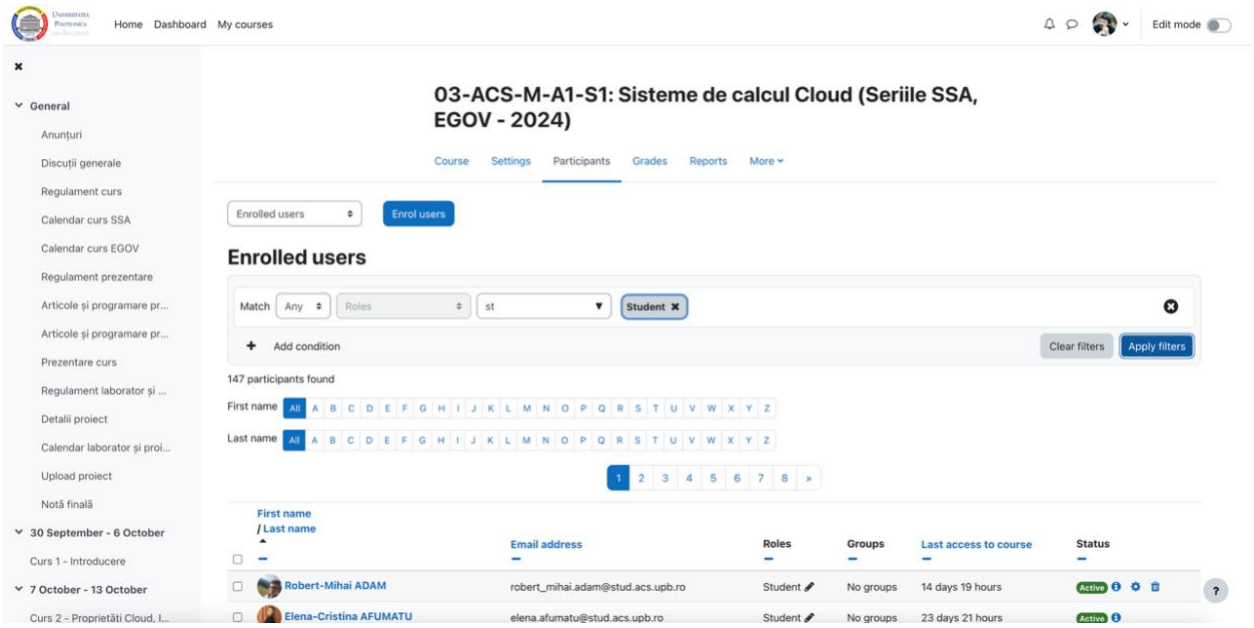
Cloud Computing



FIȘA DISCIPLINEI / COURSE SYLLABUS

1. Date despre program

1.1 Instituția de învățământ superior	Universitatea Națională de Știință și Tehnologie POLITEHNICA București
1.2 Facultatea	**Automatică şi Calculatoare**
1.3 Departamentul	**Calculatoare**
1.4 Domeniul de studii universitare	**Calculatoare și Tehnologia Informației**
1.5 Programul de studii universitare	**Servicii software avansate**
1.6 Ciclul de studii universitare	**Masterat**
1.7 Limba de predare	**Română**
1.8 Locația geografică de desfășurare a studiilor	**București**

2. Date despre disciplină

2.1 Denumirea disciplinei (ro) (en)	**Cloud Computing**
2.2 Titularul/ii activităților de curs	Prof.dr.ing. Ciprian DOBRE

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2.3 Titularul/ii activităților de seminar / laborator/proiect			Conf.dr.ing. Radu-Ioan CIOBANU				
2.4 Anul de studiu	1	2.5 Semestrul	I	2.6. Tipul de evaluare	E	2.7 Regimul disciplinei	Ob[1]
2.8 Tipul disciplinei	DA[2]		2.9 Codul discipline	UPB.03.CTI.M.09.R.I.0b.3			

3. Timpul total (ore de activități didactice pe semestru)

3.1 Număr de ore pe săptămână	4	Din care: 3.2 curs	2	3.3 seminar/laborator/proiect	2
3.4 Total ore din planul de învățământ	56	Din care: 3.5 curs	28	3.6 seminar/laborator/proiect	28
Distribuția fondului de timp:					ore
Studiul după manual, suport de curs, bibliografie și notițe Documentare suplimentară în bibliotecă, pe platformele electronice de specialitate Pregătire seminarii/ laboratoare/proiecte, teme, referate, portofolii și eseuri					40
Tutorat					8
Examinări					4
Alte activități (dacă există): activitate în echipe					17
3.7 Total ore studiu individual			**69**		
3.8 Total ore pe semestru			**125[3]**		
3.9 Numărul de credite			**5[4]**		

4. Precondiții (acolo unde este cazul)

4.1 de curriculum	Promovarea următoarelor discipline din planul de învățământ: Programarea calculatoarelor, Protocoale de Comunicaţii, Algoritmi Paraleli și Distribuiţi
4.2 de rezultate ale învățării	Înțelegerea principiilor de dezvoltare a aplicațiilor software, familiarizarea cu cel puțin o tehnologie de dezvoltare a programelor software

[1] *Obligatorie / Opțională / Facultativă – Se va completa conform planului de învățământ.*

[2] *De aprofundare/ de sinteză / complementare – Se va completa conform planului de învățământ.*

[3] *Se va calcula ținând cont că se acordă un credit pentru volumul de muncă care îi revine unui student cu frecvență la zi pentru a echivala 25 de ore de pregătire pentru dobândirea rezultatelor învățării.*

[4] Se va completa conform planului de învățământ.

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5. Condiții necesare pentru desfășurarea optimă a activităților didactice (acolo unde este cazul)

5.1 Curs	Cursul se bazează pe folosirea de materiale multimedia, așadar este necesară prezența unui videoproiector
5.2 Seminar / Laborator/Proiect	Stații de lucru și acces la Internet în cadrul sălii de laborator

6. Obiectiv general

Cursul introduce studenților noțiuni legate de Cloud Computing și îi pregătește pentru înțelegerea și folosirea corectă a conceptelor, modelelor și metodelor particulare de dezvoltare a Aplicațiilor și Serviciilor ce rulează în medii specifice de tip Cloud Computing. Cursul pornește de la prezentarea noțiunilor de bază specifice domeniului Cloud Computing, precum Infrastructure as a Service (IaaS), Container as a Service (CaaS), Platform as a Service (PaaS) și Software as a Service (SaaS), și ajunge să familiarizeze studenții cu elemente mai avansate de securitate sau modele economice de Business. La finalul cursului, studenții vor fi capabili să cunoască și să folosească corect modelele și mecanismele ce stau la baza mediilor și platformelor Cloud Computing. De asemenea, studenții vor căpăta deprinderile necesare pentru dezvoltarea corectă a Aplicațiilor și Serviciilor ce rulează în medii Cloud Computing, prin intermediul Docker și Kubernetes.

7. Rezultatele învățării

Cunoș tințe	● Descrie și diferențiază între concepte specifice domeniului Cloud Computing, precum Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Container as a Service (CaaS) și Software as a Service (SaaS). ● Definește noțiuni specifice domeniului (scalabilitate, reziliență, toleranța la defecte, virtualizarea, SLA, etc.). ● Definește aspecte legate de securitate in medii Cloud, modele economice pentru Cloud Computing, modele de Servicii Cloud. ● Înțelege și descrie mecanisme și instrumente specifice pentru dezvoltarea și execuția Serviciilor și Aplicațiilor în medii Cloud. ● Înțelege concepte specifice pentru Business Grid, Cloud Computing, Platforme și Metodologii specifice pentru dezvoltarea Serviciilor Cloud. ● Definește termenii de containere și containerizare folosind Docker, sau orchestrare de containere și microservicii prin intermediul Kubernetes.

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Aptitudini	• Implementează aplicații demonstrative bazate pe paradigma Cloud Computing. • Argumentează soluțiile identificate și modurile de rezolvare. • Lucrează și colaborează în cadrul unei echipe. • Aplică principiile de gândire critică în situații concrete. • Verifică experimental aplicațiile implementate. • Identifică soluții și elaborează arhitecturi software. • Elaborează texte științifice. • Argumentează soluțiile identificate/modurile de rezolvare.
Responsabilitate și autonomie	• Selectează surse bibliografice potrivite și le analizează. • Respectă principiile de etică academică, citând corect sursele bibliografice utilizate. • Manifestă colaborare cu ceilalți colegi și cadre didactice în desfășurarea activităților didactice. • Demonstrează autonomie în organizarea situației/contextului de învățare sau a situației problemă de rezolvat. • Aplică principii de etică/deontologie profesională în analiza impactului tehnologic al soluțiilor propuse în domeniul de specialitate asupra mediului înconjurător. • Demonstrează abilități de management al situațiilor din viața reală (gestionarea timpului colaborare vs. conflict).

8. Metode de predare

Procesul de predare va consta în modalități expozitive în prima parte a semestrului, când titularul le va prezenta studenților noțiunile de bază ale domeniului Cloud Computing, pentru a seta un minim necesar de cunoștințe pentru toți studenții. A doua parte a semestrului se va concentra pe implicarea studenților în procesul de cercetare și documentare. Ei vor avea de ales articole relevante din domeniul Cloud Computing, pe care le vor studia în echipă, și vor trebui apoi să le prezinte la curs în fața colegilor. Acest lucru va încurajarea atât exersarea abilităților de învățare independentă, cât și de colaborare în cadrul unei echipe, și nu în ultimul rând de comunicare asertivă și dezbatere publică. La aceste prezentări de curs, se va încuraja dialogul între studenții care prezintă și cei care ascultă.

9. Conținuturi

CURS		
Capitolul	**Conținutul**	**Nr. ore**
I	De la Business Grid la Cloud Computing a) Introducere, concepte, proprietăți și caracteristici b) Modele de Servicii Cloud și middleware c) Studii de caz: Eucalyptus, OpenNebula	**2**
II	Infrastructure as a Service (IaaS)	**2**

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	a) Concepte IaaS b) Virtualizarea resurselor c) Studii de caz	
III	Platform as a Service (PaaS) a) Concepte PaaS b) Platforme Cloud și gestiunea acestora c) Studii de caz	**2**
IV	Software as a Service (SaaS) a) Concepte SaaS si Business Process As A Service b) Studii de caz	**2**
V	Platforme si Metodologii pentru Deploymentul Serviciilor Cloud a) Modelul "Application As A Service" b) Securitate și confidențialitate în Cloud Computing c) Concepte specifice: Design-for the Cloud, Design-in the Cloud d) Studiu de caz: Modelul economic pay-per-usage e) Deployment în Cloud Computing	**2**
VI	Concepte avansate a) Planificare b) Consens c) Stocare d) Aplicații e) Toleranța la defecte f) Fog și Edge Computing g) Mobile Cloud Computing	**18**
	Total:	**28**

Bibliografie:

1. *C. Dobre, Cloud Computing, suport de curs electronic, disponibil la adresa* https://curs.upb.ro/2023/course/view.php?id=4552
2. *Armbrust, M., et al. Above the clouds: A Berkeley view of cloud computing. Tech. Rep. UCB/EECS-2009-28, EECS Department, U.C. Berkeley, Feb 2009.*
3. *Michael Armbrust, Armando Fox, Rean Griffith, Anthony D. Joseph, Randy Katz, Andy Konwinski, Gunho Lee, David Patterson, Ariel Rabkin, Ion Stoica, and Matei Zaharia. 2010. A view of cloud computing. Commun. ACM 53, 4 (April 2010), 50-58.*
4. *Marinescu, Dan C. Cloud computing: theory and practice. Morgan Kaufmann, 2022.*
5. *Rittinghouse, John W., and James F. Ransome. Cloud computing: implementation, management, and security. CRC press, 2017.*
6. *Rountree, Derrick, and Ileana Castrillo. The basics of cloud computing: Understanding the fundamentals of cloud computing in theory and practice. Newnes, 2013.*

LABORATOR/ SEMINAR/PROIECT		
Nr. crt.	**Conținutul**	**Nr. ore**
1.	Docker	4

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2.	Docker Swarm	4
3.	Kubernetes vs. Docker	4
4.	Instalare Kubernetes și familiarizare comenzi *kubectl*	4
5.	Deployment-uri în Kubernetes (pod-uri, rețele, volume, etc.)	6
6.	Deployment-uri în Kubernetes folosind YAML	6
	Total:	**28**

Bibliografie:

1. *Ciprian Dobre, Cloud Computing, suport de curs electronic, disponibil la adresa https://curs.upb.ro/2023/course/view.php?id=4552*
2. *https://docs.docker.com*
3. *https://kubernetes.io/docs/home/*
4. *Burns, Brendan, Joe Beda, and Kelsey Hightower. Kubernetes: up and running: dive into the future of infrastructure. O'Reilly Media, 2019*

10. Evaluare

Tip activitate	10.1 Criterii de evaluare	10.2 Metode de evaluare	10.3 Pondere din nota finală
10.4 Curs	Corectitudinea rezolvării problemelor	Examen scris	40%
	Expunerea și înțelegerea unui subiect	Prezentare	20%
10.5 Seminar/laborator/proiect	Corectitudinea rezolvării proiectului	Proiect în echipă	40%
10.6 Condiții de promovare			
• Obținerea a 50% din punctajul de la examen. • Susținerea prezentării la curs. • Prezentarea proiectului. • Obținerea a minim 50% din punctajul pe proiect și pe prezentarea de la curs.			

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At the Universidade **NOVA** de Lisboa in Portugal the digital lab will focus on the integration of digital equipment into IoT applications and services, like tools for **Smart Cities and eHealth**.

Course Syllabus – Sistemas de Aquisição de Dados (SAD) / Data Acquisition Systems (DAQ)

Abstract

The course 'Sistemas de Aquisição de Dados (SAD)' introduces students to the principles, tools, and practical applications of data acquisition systems. Throughout the semester, students explore sensor technology, analog and digital signal conditioning, serial communication, A/D conversion, and system integration using platforms such as Arduino, PIC24, and LabVIEW. The course combines theoretical grounding with hands-on practical projects to prepare students for designing, configuring, and implementing complete DAQ systems in real-world contexts. Emphasis is placed on critical thinking, collaboration, and industry-aligned competency development, culminating in an understanding of Education 4.0 frameworks and the role of cyber-physical systems in modern engineering education.

Course Metadata

Version: v1.0 – 2024/2025

Keywords: DAQ, Signal Conditioning, Sensors, Arduino, LabVIEW, Education 4.0, Cyber-Physical Systems

Jobs Requiring These Skills: Embedded Systems Engineer, Automation Engineer, Instrumentation Specialist, IoT Developer, Control Systems Engineer

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Academic Target Group: Bachelor and Master-level Engineering Students

Target Group: Electronics Students, Computer Engineering Students, Automation and Control Students

Evaluation Method: Video presentation, Peer-reviewed report, Practical project submission, Live demo

Equipment Used in Teaching: Arduino Uno, PIC24 Explorer Board, Sensors (LDR, Hall, etc.), Oscilloscope, PC with LabVIEW

Multimedia Used in Teaching: Lab simulation videos, YouTube tutorials, Live coding sessions, Presentation slides

Class Requirements: Basic electronics knowledge, Familiarity with programming (C/C++), Access to a computer with USB, Internet connection for remote labs

Course Modules

Module 1: General Introduction

- • Course structure, objectives, and tools
- • Instructor contact and class schedules
- • Moodle platform usage and bibliographic references

Module 2: Evaluation Methodology

- • Evaluation breakdown: Theoretical (CT) and Practical (CP)
- • Types of assessments: video, PDF, peer-review
- • Bonus grading system and originality verification (Turnitin)

Module 3: Practical Work 1 – Acquisition System using PIC24

- • Development of a DAQ system using Explorer16 + PIC24
- • Analog and digital channels setup
- • RS-232 communication and JSON messaging
- • Interrupt routines, ADC setup, and message formatting

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Module 4: Practical Work 2 – Arduino Sensor + App + Server Integration

- • System expansion: Arduino as I2C sensor, App on PC, communication with server
- • Integration of I2C and UART protocols
- • JSON + XML message formats and HTTP POST to remote server
- • System monitoring, configuration, and visualization

Module 5: Theoretical Component – How to Present a Study

- • Guidelines for theoretical assessment: video + PDF
- • Project definition, referencing, and plagiarism prevention
- • Instructions for PDF submission, anonymity, and peer review

Module 6: DAQ Fundamentals

- • Components of a DAQ system
- • Typical workflow: sensing, conditioning, conversion, visualization, storage
- • Real-world integration of sensors and actuators

Module 7: RS-232 Serial Communication

- • RS-232 standard, DTE/DCE architecture
- • Handshaking (hardware/software), pin configuration
- • ASCII transmission and signal timing

Module 8: Introduction to Sensors

- • Active vs passive sensors
- • Analog vs digital outputs
- • Smart sensors and signal integrity

Module 9: Signal Conditioning – Basics

- • Voltage dividers, Op-Amp amplifiers

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- • Resistance-to-voltage conversion
- • Wheatstone bridge operation

Module 10: Signal Conditioning – Filters and Converters

- • Filter types: low-pass, high-pass, band-pass, notch
- • Passive vs active filters
- • Voltage-current and frequency converters

Module 11: Resistor Sizing and Debouncing

- • Choosing resistors for LEDs and LDRs
- • Debouncing switches with pull-up/pull-down resistors

Module 12: Analog-to-Digital Conversion

- • Sampling theory and resolution
- • ADC configuration for Arduino and PIC
- • Practical voltage conversion math

Module 13: Serial Protocols – RS-485 and I2C

- • RS-485: differential transmission and multi-drop
- • I2C: addressing, master/slave, data exchange
- • Protocol strengths in DAQ usage

Module 14: Arduino Platform & Preparatory Practical Work

- • Arduino basics, TinkerCAD simulation, block programming
- • Hands-on DAQ prototype with sensors and EEPROM
- • Serial data transmission using JSON every 30 seconds

Module 15: LabVIEW – Concepts

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- • What is LabVIEW and how it applies to DAQ
- • Graphical programming paradigm
- • Signal acquisition and simple processing
- • Step-by-step DAQ simulations in LabVIEW
- • Signal visualization and block manipulation

Module 16: Remote Labs, Education 4.0 & Cyber-Physical Systems in DAQ

- • Education 4.0 and Smart Labs principles
- • Cyber-Physical Systems (CPS) in remote DAQ
- • Remote robotic arm & solar tracker learning platforms
- • Student engagement and collaborative learning

This discipline has 54 students.

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