Universidad Zaragoza

Academic Year/course: 2022/23

29514 - Coding and Information Theory

Syllabus Information

Academic Year: 2022/23
Subject: 29514 - Coding and Information Theory
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
Degree: 625 - Bachelor's Degree in Industrial Processes' Data Engineering
ECTS: 6.0
Year: 2
Semester: Second semester
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The expected result of the subject responds to the following goals

The objective of the subject is to present the main concepts of information theory from a practical point of view. When we talk about information we are really talking about the symbols used in the storage and transport of the information, but not about the creation or treatment of this information. From these ideas, we work on the codes designed to transmit information without error and data compression.

Aligned with ODS:

These approaches and objectives are in line with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment/es/), in such a way that the acquisition of the course learning outcomes provides training and competence to contribute to their achievement to some degree:

- Goal 9: Industry, Innovation and Infrastructure.

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Specific targets:

- Target 9.c: Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in the least developed countries by 2020.

1.2. Context and importance of this course in the degree

Theory of information and codification is a subject that forms part of this Engineering Degree which is imparted in EUPLA, the subjects are englobed inside the Codification, cryptography and security module.

This subject has extraordinaire importance in the acquisition of the competencies of the degree. Moreover, it gives additional useful skills for Engineering work in the codification and data compression area.

1.3. Recommendations to take this course

In order to be successful in this subject the student must pass the following subjects: Programming, Math I, II, network administration, data structure and algorithms and statistics and probability.

2. Learning goals

2.1. Competences

The student must be able to?

General competencies:

- CG03 - Apply techniques for the acquisition, management and processing of data in Engineering.
- CB1 - That students have demonstrated possession and understanding of knowledge in an area of study that starts from the base of general secondary education, and is usually found at a level that, although supported by advanced

textbooks, also includes some aspects that imply knowledge from the forefront of your field of study.
- CB3 - That students have the ability to gather and interpret relevant data (normally within their area of study) to make judgments that include a reflection on relevant issues of a social, scientific or ethical nature.
- CB4 - That students can transmit information, ideas, problems and solutions to both a specialized and non-specialized audience.

Transversal competencies:

- CT03 - Search, select and responsibly manage information and knowledge.
- CT04 - Develop critical thinking and reasoning.
- CT05 - Effective communication of results.
- CT07 - Analyze and solve problems autonomously, adapt to unforeseen situations and make decisions.

Specific competencies:

- CE10 - Use the basic principles of coding and information theory.
- CE11 - Apply the principles of data compression, error correction and security.

2.2. Learning goals

The student in order to pass the subjects must demonstrate the following results:

1. Know the concepts related to information and its applications to the theory of coding.

2.3. Importance of learning goals

This subject has a strong engineering character. It offers a significant quantity of content that is very useful to the labour and professional market. When the student reaches the learning outcomes he obtains the necessaire capability to understand the information codification systems, which are essential to the design and setup of each complex process, etc. included in the Data Engineering field.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student must demonstrate that he has reached the expected learning results with the next evaluation activities:

1. Practical work (30%). These Works included laboratory workshops and problem-solving. In the laboratory workshop, the student must make a previous study that must give before the beginning of the practice. The final mark is based on the quality of the analysis and the obtained results given in a written document. In order to pass the subject, the student must have a mark of at least five points.
2. In written tests (70%), the student can find some questions or need to solve an engineering problem like the ones resolved in the theoretical lessons. We value the quality and clarity of the provided solution, the used concepts, the absence of errors in developing and solution, and the right use of the terminology and notation. In order to pass the subject, the student must have a mark of at least five points on each test.

The student may choose between continuous evaluation or global evaluation. The continuous evaluation consists of two written tests plus written essays in a laboratory workshop. The global evaluation consists of a written test at the end of the course and the written essays in a laboratory workshop.

The student that suspends any part of the continuous evaluation can pass it in the global test.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The learning process is designed following these key ideas:

There is a strong interaction between teacher and student. This interaction is brought into being through a division of work and responsibilities between the students and the teacher. Nevertheless, it must be taken into account that, to a certain degree, students can set their learning pace based on their own needs and availability, following the guidelines set by the teacher.

The current subject is conceived as a stand-alone combination of contents, yet organized into three fundamental and complementary forms: the theoretical concepts of each teaching unit, the solving of problems or resolution of questions and laboratory work, at the same time supported by other activities.

The organization of teaching will be carried out using the following steps:

- **Lectures**: Theoretical activities are carried out mainly through exposition by the teacher, where the theoretical supports of the subject are displayed, highlighting the fundamentals, structuring them in topics and or sections, and interrelating them.
- **Practice Sessions**: The teacher resolves practical problems or cases for demonstrative purposes. This type of teaching complements the theory shown in the lectures with practical aspects.
- **Laboratory Workshop**: The lecture group is divided up into various groups, according to the number of registered students, but never with more than 20 students, in order to make up smaller-sized groups.
- **Individual Tutorials**: Those carried out by giving individual, personalized attention to a teacher from the department. Said tutorials may be in person or online.

If classroom teaching were not possible due to health reasons, it would be carried out online.

4.2. Learning tasks

The course involves the active participation of the student, in a way that the results achieved in the learning process are developed, not taking away from those already set out, the activities are the following:

Face-to-face generic activities:

- **Lectures**: The theoretical concepts of the subject are explained and illustrative examples are developed as a support to the theory when necessary.
- **Practice Sessions**: Problems and practical cases are carried out, complementary to the theoretical concepts studied.
- **Laboratory Workshop**: This work is tutored by a teacher.

Generic non-class activities:

- Study and understand the theory taught in the lectures.
- Understanding and assimilation of the problems and practical cases solved in the practical classes.
- Preparation of seminars, solutions to proposed problems, etc.
- Preparation of laboratory workshops, preparation of summaries and reports.
- Preparation of the written tests for continuous assessment and final exams.

The subject has 6 ECTS credits, which represents 150 hours of student work in the subject during the trimester, in other words, 10 hours per week for 15 weeks of class.

A summary of a weekly timetable guide can be seen in the following table. These figures are obtained from the subject file in the Accreditation Report of the degree, taking into account the moderate level of experimentation considered for the said subject.

Activity	**Hours per week**
Lectures	3
Laboratory workshop	1
Other activities	6

Nevertheless, the previous table can be shown in greater detail, taking into account the following overall distribution:

- 44 hours of lectures, with 50% theoretical demonstration and 50% solving type problems.
- 12 hours of laboratory workshop, in 1 or 2-hour sessions.
- 4 hours of written assessment tests, one hour per test.
- 40 hours of teamwork divided up over the 15 weeks of the semester.
- 50 hours of personal study, divided up over the 15 weeks of the semester.

4.3. Syllabus

The course will address the following topics:

The theoretical program

Topic 1: Introduction to information theory

- Model of a communications system
- Source of information
- Communication channels
    - with noise
    - Without noise

- source encoding
- channel coding

Topic2: Entropy

- Basic measures in information theory
- relative entropy
- mutual information

Topic3: Source coding

- block codes
- Shannon's first theorem
- Huffman algorithm
- compression techniques

Topic 4: Channel Capacity

- mutual information
- Information processing theorem
- channel capacity
- Capacity calculation

Topic 5: Noisy Channels

- Reliable transmission on an unreliable medium
- Shannon's second theorem
- Capacity limit on a noisy channel
- Optimal decoding

Topic 6: Error control with linear codes

- Definition
- generating matrix
- Parity check array
- Error detection and correction
- hamming codes

Topic 7: Error control with cyclic codes

- Definition, systematic cyclic codes
- Matrix and circuit description
- error detection

Topic 8: Relay Protocols

- ARQ Types
- Analysis of ARQ techniques

Topic 9: Source Compression: Audio, Image, and Video

- Audio
- Image
- Video

Topic 10: Introduction to BCH, RS and convolutional codes

- Introduction to BCH codes
- Introduction to Reed Solomon Codes
- Introduction to convolutional codes

Materials

Material	**Support**
Topic theory notes / Topic problems	Paper
Topic presentations / Topic problems / Related links	Digital/Moodle

Educational software	Web page

4.4. Course planning and calendar

The class hall sessions & work presentations timetable will be presented at https://moodle2.unizar.es/add/

The dates of the final exams will be those that are officially published at http://www.eupla.unizar.es/asuntos-academicos/examenes

The written assessment tests will be related to the following topics:

? **Test 1**: Topic 1, 2, 3, 4 & 5.

? **Test 2**: Topic 6, 7, 8, 9 & 10.

At the end of every topic, the student can find some reinforcing exercises in order to guide him in their personal homework.

The activities of this subject and its temporal schedule depend on the academic organization proposed by the faculty in EUPLA and you can read it in section 5, activities and resources.

At www.eupla.unizar.es you can check the exam dates.

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=29514