Universidad Zaragoza

**Year : 2020/21**

# 28712 - Materials: Science and Technology

## Syllabus Information

**Academic Year:** 2020/21
**Subject:** 28712 - Materials: Science and Technology
**Faculty / School:** 175 - Escuela Universitaria Politécnica de La Almunia
**Degree:** 423 - Bachelor's Degree in Civil Engineering
**ECTS:** 6.0
**Year:** 2
**Semester:** Second semester
**Subject Type:** Compulsory
**Module:** ---

# 1.General information

## 1.1.Aims of the course

The main goal of the course is to teah the basic concepts of materials engineering and to study the different types of materials in the construction sector. The content aims to provide an adequate response to the necessities that the future engineer will have afther finalising his/her degree (by the acquisition of knowledge and skills that meets the needs required by today's engineering companies)

Taking into account the students to whom the subject is addressed, the focus, as well as the content, should be directed, fundamentally, to the student knowing of the basics of the science of materials, the classification of the various families of materials , their properties, applications and behaviour in service, and the technology developed to improve the properties of the materials, in such a way that allows to any student to be able to choose the most suitable material for each application.

## 1.2.Context and importance of this course in the degree

The subject of Materials: Science and Technology is part of the degree in Civil Engineering taught by EUPLA, framed within the group of subjects that make up the module called Technical and Technological Building Education. It is a subject of the second year and compulsory in the second semester (OB), with a teaching load of 6 ECTS credits. Its contents must provide the basic knowledge necessary for the follow-up of the later subjects of the Curriculum.

Each subject of which the race is composed tries to cover a field in the Technological and Scientific formation of the student, in this case the selection of the material the first step to build. The viability of the project will depend not only on the chosen material, but also on the design and aesthetics of the project. In addition, it should be a basic subject for the development of the subsequent "Building Works, Construction of railway infrastructures, Construction of transport infrastructure: roads and structures", which will expand and deepen in some concepts already discussed.

To be able to choose a material one must know its mechanical, chemical, optical characteristics, the behavior with other materials and the durability that it may present depending on the environments in which it is located.

## 1.3.Recommendations to take this course

Officially, the current curriculum does not lay down any prerequisite to take this subject. However, the content to be taken will require skills and abilities, mainly in the subjects Physics, Mathematics and Chemistry (from previous academic years).

# 2.Learning goals

## 2.1.Competences

The student acquired generic and specific competences that mark the verification memory of the degree.

Upon passing the subject, the student will be more competent to ...

- C03 - Ability to apply knowledge of construction materials in structural systems. Knowledge of the relationship between the structure of materials and the mechanical properties derived from it.
- G01 - Organizational and planning capacity
- G02 - Ability to solve problems
- G03 - Ability to make decisions
- G04 - Aptitude for oral and written communication of the native language
- G05 - Capacity for analysis and synthesis
- G06 - Information management capacity

- G07 - Ability to work in a team
- G08 - Capacity for critical reasoning
- G09 - Ability to work in an interdisciplinary team
- G10 - Ability to work in an international context
- G11 - Improvisation and adaptation ability to face new situations
- G12 - Leadership aptitude
- G13 - Positive social attitude towards social and technological innovations
- G14 - Ability to reason, discuss and present ideas
- G15 - Ability to communicate through words and images
- G16 - Ability to search, analyze and select information
- G17 - Ability for autonomous learning
- G23 - Know and understand respect for fundamental rights, equal opportunities between women and men, universal accessibility for people with disabilities, and respect for the values ??of the culture of peace and democratic values
- G24 - Promote entrepreneurship
- G25 - Knowledge of information and communication technologies

### 2.2.Learning goals

**The student, to pass this subject, must demonstrate the following results ...**

1.To Know the behavior and technology of materials.

2. To Explain the manufacturing technologies and the implementation technologies of the different materials.

3. To Explain the differentiating criteria for the ?classification? of the different families of construction materials (concretes, bituminous mixtures, aggregates, firm, composite materials) according to the structure and properties they present.

4. It is able to relate the properties of the materials with the structure and / or microstructure.

5. It is able to relate the properties of the materials, obtained from the tests, with the applications and their behavior in service.

6. It is able to choose the materials based on the applications and their behavior in service.

7. Has a sufficient knowledge base to broaden and deepen the study and development of the materials used in construction.

8. To Know the importance of innovation in the development of manufacturing, commissioning and application of materials.

9. Has the ability to critically analyze the results obtained in an experimental work and extract correct conclusions, as well as propose future work that, in light of these conclusions.

10. Is capable of carrying out, individually and / or in teams, a research experiment in the field of Materials Engineering in a correct way and observing the necessary standards of safety, hygiene, economy of means, etc.

### 2.3.Importance of learning goals

This course is highly technical, that is, it offers training with application content and immediate development in the labor and professional market. For this, the subject Science and Technology of Materials constitutes one of the pillars on which their training must be based, since the structures, components, devices ... that the Graduate will design, manufacture, use and supervise, are made up of materials , and it is the properties of these that, ultimately, define both the limits of use and the capacities of the structure or device, as well as the techniques that can be used for its manufacture.

For all these reasons, the acquisition of basic knowledge about the most relevant properties of materials, and the relationship between them and their composition and structure, should constitute a fundamental aspect of the formation of a Graduate. /to.

At the end of the subject, the student will have knowledge of the materials used in the building, their varieties, and the physical and mechanical characteristics that define them. Ability to adapt construction materials to the type and use of the building, manage and direct the reception and quality control of the materials, their placement, control of the execution of the work units and the conduct of tests and trials endings. Likewise, it will be able to manage and direct the reception and quality control of the materials in the works.

## 3.Assessment (1st and 2nd call)

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

**Continuous Assessment System**

To opt for the Continuous Assessment system, you must attend at least 80% of the face-to-face classes (to carry out the tasks that are developed during the classes) and complete the laboratory practices on the days indicated in Moodle for this purpose.

The student must demonstrate that they have achieved the expected learning outcomes by evaluating the following activities:

- Written assessment tests: They will consist of a classic written exam scored from 0 to 10 points.

- Exercises, theoretical questions and proposed works: The teacher will propose exercises, problems, practical cases, theoretical questions, etc. to be solved individually.
- Individual activities in class: This activity will materialize in the presentation, exposition and discussion of a work in PPT, in class and directed to their classmates.
- Laboratory sessions: They will not count in the final grade, but will be compulsory to be eligible for this type of evaluation. For its development the student will have scripts or will have to do them according to the indications of the person in charge of practices.

As a summary of the above, the following weighting table of the grading process of the different activities has been designed, in which the final evaluation process of the subject has been structured:

Evaluation / weighting activity:

- Individual activities in class, exercises, theoretical questions and proposed works (PPT presentations). 10%
- Theory written exams: 45%.
- Written exam of practice problems: 45%
- Laboratory practices: 0%

The course will have been passed based on the sum of the scores obtained in the different activities carried out (as indicated above), obtaining a minimum of 50% of the total. Each one of the tests (theoretical / problem) will contribute to the grade and it is essential to obtain a minimum of 40% in the part of problems. The written tests must all be passed (> = 50%).

There will be a presentation of the subject on the first day of class where the parts that make up the continuous assessment, the assessment criteria and the teaching method followed will be indicated.

**Global Assessment System**

Following the regulations of the University of Zaragoza in this regard, in subjects that have continuous or gradual evaluation systems, a global evaluation test will be scheduled for those students who decide to opt for this second system or do not meet the evaluation requirements. keep going.

As a summary of the above, the following weighting table of the grading process of the different activities has been designed, in which the final evaluation process of the subject has been structured:

Evaluation / weighting activity:

- Theory written exam: 50%
- Written exam of practice problems: 50%

The course will have been passed based on the sum of the scores obtained in the different activities carried out, each contributing a minimum of 50%. Each of the tests (theoretical / problems) will contribute 50% of the grade, and it is essential to obtain at least 40% in each of them.

The theory or practice part may be saved between assessment calls of the same course. In addition, the part passed in the continuous evaluation will also be saved in the global evaluation.

# 4.Methodology, learning tasks, syllabus and resources

## 4.1.Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as lectures, practice sessions, workshops, and tutorials.

The teaching methodology is based on a strong interaction between the teacher/student. This interaction is made a reality 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 course SCIENCE AND TECHNOLOGY OF MATERIALS is conceived as a stand-alone combination of contents, yet organized into three fundamental and complementary ways, which are: the theoretical concepts of each topic, problem-solving or resolution of questions and laboratory work, supported in turn by other activities.

**If classroom teaching were not possible due to health reasons, it would be carried out on-line.**

## 4.2.Learning tasks

This course is organized as follows:

- **Theory sessions**: The theoretical concepts of the subject are explained and illustrative examples are developed as support to the theory when necessary.
- **Practical sessions**: Problems and practical cases are carried out, complementary to the theoretical concepts studied.
- **Workshop**: This work is tutored by a teacher, in groups of no more than 20 students.

- **Tutorials**
  - **Group tutorials:** Learning tracking scheduled activities in which the teacher meets with a group of students to guide their autonomous work and study that requires a very high degree of counselling from the teacher.
  - **Individual tutorials**: On-site or online
- **Autonomous work and study.**
  - Study and understanding of 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.
- **Assisted Autonomous activities**: Although they will have a strong on-site character, they will be focused mainly on seminars and tutorials under the supervision of the teacher.
- **Reinforcement activities**: With a strong non-class character, through a virtual learning portal (Moodle) several activities that reinforce the basic contents of the subject will be conducted. These activities might be customized or not, but always under control.

## 4.3.Syllabus

This course will address the following topics:

**Theoretical Contents**

**Topic 1: Aggregates and Roadbeds**

1. Origin of aggregates
2. Physical and mechanical properties
3. Classification of aggregates
4. Setting of aggregates
5. Embankment, Grading & Roadbeds
6. Applications

**Topic 2: Bitumen**

1. Origin of bitumen
2. Rheological test of bitumens
3. Classification of bitumens
4. NFU (out of used tyres in bitumens)
5. Bituminous Emulsions
6. Bitumen applications

**Topic 3: Bituminous Mixtures (Asphalt Concrete)**

1. Production
2. Transport
3. On-site positioning
4. Mix Typologies
5. Mix Classification
6. Mix Rheology
7. Regulations
8. Pathologies

**Topic 4: Metals**

1. Introduction
2. Crystal structure
3. Formation and nature of alloys
4. Mechanical properties
5. Concepts
6. Physical Properties
7. Chemical properties

8. Unions
9. Forming
10. Iron and its alloys
11. Copper and its alloys
12. Aluminum and its alloys

**Topic 5: Cement (-)**

1. Nature of cements
2. Raw materials of cements
3. Cement production
4. Cement constituents
5. Cement hydration
6. Classification of cements
7. Properties of cements
8. Test of cements
9. Uses of cement

**Topic 6: Concretes**

1. History
2. Manufacturing
3. Transport
4. On-site positioning
5. Fresh Concrete
6. Water
7. Aggregates
8. Durability
9. Additives
10. Concrete curing
11. Creep and shrinkage of concrete
12. Hardened concrete
13. Mechanical testing
14. Regulations
15. Pathologies

**Practical Contents**
The theoretical knowledge of the previous section, has associated practice tasks. The Laboratory practice tasks in Science and Technology of Materials are an important complement to the comprehensive training of the student in the Civil Engineering degree.

It is impossible to even try to give a minimal description of the different types of gadgets and commercial devices used for measuring different magnitudes. This is not the purpose of the course. The purpose is to cover the learning outcomes through a comprehensive program of laboratory practice activities, including aspects related to the following issues:

- Generically, a clear idea of ??the importance of the field of material testing as well as the implementation time and their application.
- Students must, at least, acquire knowledge about the most common techniques for measuring magnitudes such as mechanical resistance, chemical resistance, environmental resistance, etc. of the materials used in construction.

The guidelines followed to develop the contents were as follows:

- The contents proposed in the verification report were respected.

- A syllabus whose chapters are generally consistent with the titles of the specified program was developed. When this was not done it was because, due to its size and / or correlation, it was included in another.

- A large bibliography of current technical, classical and issues was selected

- The best suited Topics from the bibliography were selected and turned into a single text, with our own design and layout and innovative teaching resources. The teacher didn't mean to be creative in its preparation, but he based his work on renowned prestige texts. Only the goals, organization and presentation of the material and drafting of some sections of the issues are original. The full text is available in the reprographic service of the school, as well as on digital media published in Moodle.

- The main features of the text layout can be summarized as having nine Topics, which coincide with the content, completely developed, avoiding summaries.

- The specific goals achieved in the making of the text itself can be summarized as follows:

- Highlight the relationship between conceptual analysis and problem solving, using the number of examples needed to show approaches for their solution, stressing that solving is a process in which the conceptual knowledge is applied, and it is not merely a mechanized solving model. Therefore, in the text and the solved examples, the mind processes for problem solving based on the concepts are stressed, instead of highlighting the mechanical procedures.
- Provide students with practice in the use of analytical techniques presented in the text.
- Show students that the analytical techniques are tools, not goals, allowing in different situations to practice in choosing the analytical method they will use to obtain the solution.
- Encourage student interest in engineering activities, including real application problems.
- Develop problems and exercises using realistic values ??representing feasible situations.
- Encourage students to evaluate the solution, either with a different method of resolution or by testing to see if it makes sense in terms of the known behavior of the circuit, machine or system.
- Show students how the results of a solution are used to find additional information about the behavior of a circuit, machine or system.
- The resolution of most problems will require the type of analysis to be performed by an engineer to solve real-world problems. Developed examples, where the particular way of thinking of engineering is emphasized, can also be used as a basis for solving real problems.

## 4.4.Course planning and calendar

- This course has 6 ECTS, which represents 150 hours of student work in the subject during the semester, in other words, 10 hours per week for 15 teaching weeks. This includes 3 hours of lectures, 1 of workshop and 6 of other activities every week.

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

  - 32 hours of lectures, with 70% theoretical demonstration and 30% solving type problems.
  - 2 hours of laboratory workshop, in 2 hours per sessions.
  - 8 hours of written assessment tests, 2 hours per test.
  - 8 hours of PPT presentations, 1 hour per PPT
  - 90 hours of personal study, over the 15 weeks of the 2$^{nd}$ term.

  Tasks to be developed in the laboratory will be carried out by the students in sessions of two hours.

  Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course will be provided on the first day of class or please refer to the EUPLA website:

  - https://eupla.unizar.es/
  - https://eupla.unizar.es/asuntos-academicos/calendario-y-horarios
  - https://eupla.unizar.es/asuntos-academicos/examenes

## 4.5.Bibliography and recommended resources

**Materials**

| Materials | **Source** |
|---|---|
| Topic theory notes<br>Topic problems | Paper/repository |
| Topic theory notes<br>Topic presentations<br>Topic problems<br>Related links | Digital/Moodle<br>E-Mail |
| Test material | Laboratory computers |
| Practice guidelines | Paper/repository |
| Multi-test machines<br>Sieves<br>Test tube molds | |

| | |
|---|---|
| Trays<br>Etc. | |

## Bibliography

http://biblos.unizar.es/br/br_citas.php?codigo=28712&year=2020


- Código Técnico de la Edificación - [https://www.codigotecnico.org/index.php/menu-documentoscte.html]
- EHE - [ https://www.fomento.gob.es/organos-colegiados/mas-organos-colegiados/comision-permanente-del-hormigon/cph/ins ]
- PG-3 - [http://www.carreteros.org/normativa/pg3/apartados/indice.htm]