COURSE DATA

Data Subject	
Code	34211
Name	Materials Science
Cycle	Grade
ECTS Credits	6.0
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	4	First term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	11 - Chemical Industry	Obligatory

Coordination

Name	Department
IBAÑEZ PUCHADES, RAFAEL	320 - Inorganic Chemistry

SUMMARY

The aim of this course is to establish the basis for students to understand the relationship between structure, processing and properties of materials.

Materials are classified into five main categories: metallic materials and alloys, ceramics, glasses, polymers and composite materials.

This subject deals with the mechanical, electrical, optical and magnetic properties of each type of material.

The electronic structure of each material and its crystalline or amorphous structure are used to explain its properties. The existence of defects and imperfections in solids will also be used in the interpretation of properties.

Once the properties of each material have been studied, the subject will address their potential applications.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

This is a interdisplicinar subject, therefore it is related to all the subjects studied previously. It manage all the concepts studied in previous courses to interpret the relation between structure and properties of the different types of materials.

OUTCOMES

1108 - Degree in Chemistry

- Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation.
- Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.
- Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.
- Demonstrate the ability to adapt to new situations.
- Interpret the variation of the characteristic properties of chemical elements according to the periodic table.
- Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications.
- Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids and other materials.
- Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry.
- Solve qualitative and quantitative problems following previously developed models.
- Recognise and analyse new problems and plan strategies to solve them.
- Relate theory and experimentation.
- Recognise and evaluate chemical processes in daily life.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.

- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.
- Have basic skills in the use of information and communication technology and properly manage the information obtained.

LEARNING OUTCOMES

The previous section includes the competences contained in the document VERIFICA. This subject addresses part of the learning results of the matter Chemical Industry and that allow to acquire specific knowledge of chemistry, cognitive skills and general skills recommended by the EUROPEAN CHEMISTRY THEMATIC NETWORK (ECTN) for the Chemistry Eurobachelor® Label. The following table lists the learning outcomes acquired in the subject Materials Science related to the competences of the degree in Chemistry.

SPECIFIC KNOWLEDGE OF CHEMISTRY	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Materials Science **that contemplate the learning outcomes EUROBACHELOR®**
The principal techniques of structural investigations, including spectroscopy	Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications..(CE7).
The characteristics of the different states of matter and the theories used to describe them.	Demonstrate knowledge of the characteristics and behaviour of the different states of matter and the theories used to describe them..(CE3).

COMPETENCES AND COGNITIVE SKILLS
The learning process should allow the degree graduates to demonstrate:

	Competences of the subject Materials Science **that contemplate the learning outcomes EUROBACHELOR®**
Ability to demonstrate knowledge and understanding of the facts, concepts, principles and fundamental theories related to the topics mentioned above.	Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry..(CE13).
Ability to apply this knowledge and understanding to the solution of common qualitative and quantitative problems.	Solve qualitative and quantitative problems following previously developed models..(CE14). Recognise and analyse new problems and plan strategies to solve them..(CE15). Understand the qualitative and quantitative aspects of chemical problems..(CE24).
Ability to calculate and process data, related to information and chemistry data.	Solve qualitative and quantitative problems following previously developed models..(CE14). Recognise and analyse new problems and plan strategies to solve them..(CE15).

GENERAL COMPETENCES	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Materials Science **that contemplate the learning outcomes EUROBACHELOR®**
Ability to apply practical knowledge to solve problems related to qualitative and quantitative information.	Solve problems effectively..(CG4). Solve qualitative and quantitative problems following previously developed models..(CE14). Relate theory and experimentation..(CE22). Recognise and evaluate chemical processes in daily

	life..(CE23). Understand the qualitative and quantitative aspects of chemical problems..(CE24).
Ability to analyse materials and synthesize concepts.	Develop capacity for analysis, synthesis and critical thinking..(CG1). Show inductive and deductive reasoning ability..(CG2). Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration..(CB3).
Skills related to information technology such as word processing, spreadsheet, recording and storage of data, internet use related to the subjects.	Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate..(CG6). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT3).
Study skills necessary for professional development. These will include the ability to work autonomously.	Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation..(CG3). Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Learn autonomously.(CG8). Demonstrate the ability to adapt to new situations..(CG9). Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.(CB5).

At the end of the course students should be able to

- Demonstrate ability to develop theoretical models and theoretical-experimental able to be used in the quantification of real systems, determining their validity and scope.

- Know the characteristics and significance of Chemical Industry.

- Projecting processing systems to obtain a final product according to given specifications.

- To acquire the minimum knowledge with which to understand the basis for the use of different materials in the industry, according to their physicochemical properties.

- Discriminate between different materials and choosing the most suitable according to the required performance technologically.

- Know the major industrial processes in the field of inorganic chemistry.

- Know the materials used in these processes and their manipulation at the source.

DESCRIPTION OF CONTENTS

1. Introduction

Evolution of materials throughout history. Current status of the subject. Trends in research of new materials. Classification of materials.

2. Extension and revision of basic concepts. Imperfections in solids. Diffusion.

Types of defects in solids: Point defects, line defects or dislocations, surface defects, volume defects. Defect observation: optical microscopy, electronic microscopy, SEM and TEM observation of defects. Size grain.

Diffusion mechanisms in solids. Difusión by vacancies. Interstitial diffusion. Laws of difusión. Steady and non-steady state. Example: A steel carburizing.

3. Metalic materials and alloys

Metallic materials: metals, alloys, intermetallic compounds. Mechanical properties of metals: Tensile, compression, shear and torsion. Elastic deformation and plastic deformation. Breaking: fracture types. Fatigue. Hardness: Hardening mechanisms. Alloys: definitions and concepts: component, system, solubility limit, phase, etc. Isomorphic binary systems: Alloy Ni / Cu. Development of micro-structures. Mechanical properties of alloys isomorphic. Binary eutectic systems: Cu-Ag, Pb-Sn. Development of micro-structures. Intermediates systems: Sn-Zn. Fe-carbon system. Steels. Metal forming. Ferrous alloys. Nonferrous alloys.
Electrical properties: Conductivity: electronic conductivity. Energy band structure of solids. Semiconductors: Types, devices. Superconductivity.
Magnetic properties: Types of magnetic behavior: Diamagnetism and paramagnetism, ferromagnetism and ferrimagnetism. Piezolectricity. Effect of temperature on the magnetic behavior. Domains and hysteresis.

4. Ceramics

Concept of ceramic material. Classification of ceramic materials. Raw materials: Formulation and composition. Clays and kaolins. Lamellar structure of the clays. Thermal analysis in ceramics. Ceramic manufacturing process. Wet and dry pathways. Steps of fabrication process. Composition of fired ceramic material. Ceramic Glazes: Formulation and composition. Ceramic colorants. Mechanical properties of ceramics. Electrical properties of ceramics. Insulators. Advanced Ceramics. Preceramic route, precursors polymers of non-oxide ceramics. Applications and examples.

5. Glass

The glassy state. Glass definition. The glass transition, Tg. Thermodynamics and kinetics of the glass transition. Phase miscibility. Bell miscibility.
Oxide glasses. Rules predicting the formation of glass. Models for the formation of glass. Glass forming oxides, modifier oxides and intermediate oxides.
Silicate glasses. Types of environments for silicon atom. Theoretical and true distribution of environments, 29Si NMR solid state.
Borosilicate glasses, Pyrex glass, aluminosilicate glass, other types of glass, lead glass. Composition of the different glasses.
Conforming of glass. Tempered glass. Floated glass, safety glass, special glasses
Optical properties of glass. Optic fibre. Applications of fibre optics in communication.

6. Polymers

Polymer definition. Organic polymers, inorganic polymers. Molecular weight and degree of polymerization. Comparison of techniques for determining molecular weights polymers. Polymer molecular structure: linear polymers, branched polymers, cross-linked polymers. Tacticity in polymers. Crystallinity of polymers. Degree of crystallinity, depending factors. Determining the crystallinity degree. Differential scan calorimetry for polymers. Glass transition temperature, factors which depend. Polymerization reactions. Most important types of polymers and their applications. Mechanical properties: Rigid and flexible plastics. Elastomers. Thermo-mechanical properties. Visco-elasticity. Immiscibility of the polymers. Block polymers.

7. Composites

Combined action principle: Matrix and dispersed phase. Reinforced materials: particulate reinforced materials. Fiber reinforced materials. Structural materials.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	51,00	100
Tutorials	9,00	100
Study and independent work	70,00	0
Readings supplementary material	5,00	0
Preparation of evaluation activities	15,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

This subject is designed so that students lead their own learning and is structured in the following components:

Lectures.- In these classes the lecturer will provide an overview of the topic under study with special emphasis on new aspects or on those particularly complex. Lessons will also involve the specific application of the knowledge acquired by students via the resolution of questions and practical problems that students have previously worked on. Logically, these classes must be complemented with individual study.

Group tutoring.- Students attend these sessions in small groups. In them, the lecturer may propose activities such as resolution of questions or problems, answer to queries, approach to discussions, etc.

EVALUATION

The knowledge acquired will be evaluated by an examination, in the periods established by the Faculty, which will make the largest contribution to the final grade.

The examination will consist of objective questions, dedicated to those knowledge considered as basic and of numerical and relationship problems that require to contemplate aspects of the subject that appear in different tòpics. Students who do not pass in the first call must take the second exam.

The student's participation in any activity proposed, related to the subject, can be positively assessed, including:

• Problems and qüestions solving.

• Participation in discussions and seminars.

• Content or coursework making.

The overall note will be that of the exam plus the one obtained in all the activities raised, with the weight that each teacher establishes and communicates at the beginning of the course.

To approve the subject, a minimum grade of 5 must be reached in each of the evaluation sections.

REFERENCES

Basic

- W. D. Callister and D. G. Rethwisch, Ciencia e ingeniería de materiales. Ed. Reverte, 2016. ISBN: 9788429172515
- Smith, W. F.; Ciencia e Ingeniería de Materiales. 3ª Ed. MADRID, S.A. MCGRAW-HILL / INTERAMERICANA DE ESPAÑA, 2004,ISBN: 9788448129569
- Askeland, D.R.; Ciencia e Ingeniería de los Materiales. 3ª Ed. Mejico D.F., International Thomson Editores. 1998 ISBN: 968-7529-36-9
- Callister, W.D.; Rethwisch, D. G.; Materials Science and Engineering, SI Version, Ninth Ed., Wiley, 2014, ISBN: 978-1-118-31922-2

Additional

- Greenwood, N.N.; Cristales iónicos, defectos reticulares y no estequiometria, iª Ed. Madrid, Ed. Alhambra, 1970, ISBN: 978-84-205-0197-0
- Hoffman, R.; Solids and Surfaces. A Chemist´s View of Bonding in Extended Structures, 1ª Ed. New York, 1988, Willey-VCH, ISBN-13: 978-0471187103

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

Contents

1.- The contents initially indicated in the teaching guide are maintained.

Workload and temporary teaching planning

Regarding the workload:

1.- The different activities described in the Teaching Guide are maintained with the intended dedication.

Regarding the temporary teaching planning:

1.- The material to follow the theory/tutoring/classroom-seminar classes allows to continue the temporary teaching planning both in days and schedule, whether the teaching is face-to-face in the classroom or not.

Teaching Methodology

100% face-to-face teaching.

If there is a closure of the facilities for health reasons that totally or partially affects the classes of the course, they will be replaced by non-face-to-face sessions following the established schedules and using the tools of the virtual classroom.

The methodology used for non-face-to-face classes shall be:

1. Synchronously using virtual classroom tools (Teams, Blackboard, etc.)

2. Asynchronously using presentations with audio narration or other virtual classroom tools

3. Resolution of exercises and questionnaires

Evaluation

1. The possibility of exam-only evaluation is eliminated.

2. The evaluation system described in the Teaching Guide of the subject in which the various evaluable activities have been specified as well as their contribution to the final grade of the subject is maintained.

If there is a closure of the facilities for health reasons affecting the development of any face-to-face evaluable activity of the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode using the computer tools licensed by the University of Valencia. The contribution of each evaluable activity to the final grade of the subject will remain unchanged, as set out in this guide.

References

The literature recommended in the Teaching Guide is maintained since it is accessible, and it is complemented by notes, slides and problems uploaded to the Virtual Classroom as material of the course.