COURSE DATA

Data Subject	
Code	34220
Name	Industrial and ceramic inorganic chemistry
Cycle	Grade
ECTS Credits	6.0
Academic year	2019 - 2020

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	16 - Inorganic Chemistry Applied	Optional

Coordination

Name	Department
ALARCON NAVARRO, JAVIER	320 - Inorganic Chemistry

SUMMARY

Industrial inorganic chemistry is an important branch of industry for its important diversity of finished products which include mineral fertilizers, construction materials, glass, enamels, etc., and for its basic products for the chemical industry such as mineral acids, alkalis, oxidizing agents and halogens. It is noteworthy that modern developments in industry such as microelectronic chips, CDs and optical fibres are a reality for the great development achieved by the inorganic chemical industry.

This subject places special emphasis on the manufacturing processes and the applications of the products, taking into consideration aspects such as raw materials, preservation of the environment and other ecological, economic and energy consumption issues. An additional aim is to introduce students to the techniques of preparation and characterisation of traditional and advanced ceramic materials, i.e., those with interesting physical and chemical properties that are used both independently and as part of devices. Contents also deal with the thermodynamic and kinetic aspects of the reactivity of solids, which are very important for the preparation and manufacture of ceramic materials.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

It is advisable that students have successfully completed all the subjects in previous academic years.

OUTCOMES

1108 - Degree in Chemistry

- Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.
- Interpret the variation of the characteristic properties of chemical elements according to the periodic table.
- Demonstrate knowledge of the characteristics and behaviour of the different states of matter and the theories used to describe them.
- Demonstrate knowledge of the principles of quantum mechanics and their application to the description of the structure and properties of atoms and molecules.
- 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.
- Handle chemicals safely.
- Carry out standard experimental procedures involved in synthetic and analytical work, in relation to organic and inorganic systems.
- Relate chemistry with other disciplines.
- 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.

LEARNING OUTCOMES

The previous section includes the competences contained in the document VERIFICA. This subject addresses part of the learning results of the matter Industrial and Ceramic Inorganic Chemistry 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 Industrial and Ceramic Inorganic Chemistry 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 Industrial and Ceramic Inorganic Chemistry that contemplate the learning outcomes EUROBACHELOR®
The major types of chemical reaction and the main characteristics associated with them.	Demonstrate knowledge of the main types of chemical reaction and their main characteristics.(CE4).
The principles and procedures used in chemical analysis and the characterisation of chemical compounds.	Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.(CE8). Show knowledge of the metrology of chemical processes including quality management.(CE10). Handle the instrumentation used in the different areas of chemistry.(CE19). Understand the qualitative and quantitative aspects of chemical problems.(CE24). Develop sustainable and environmentally friendly methods.(CE25).
The principal techniques of structural	Ability to recognise chemical elements and their

investigations, including spectroscopy	compounds: preparation, structure, reactivity, properties and applications.(CE7). Show knowledge of the structure and reactivity of the main classes of biomolecules and the chemistry of the main biological processes.(CE12). Handle the instrumentation used in the different areas of chemistry.(CE19). Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.(CE8).
The principles of thermodynamics and their applications to chemistry	Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry.(CE6).
COMPETENCES AND COGNITIVE SKILLS	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Industrial and Ceramic Inorganic Chemistry 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).
COMPETENCES AND COGNITIVE SKILLS RELATED TO THE PRACTICE OF CHEMISTRY	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Industrial and Ceramic Inorganic Chemistry that contemplate the learning outcomes EUROBACHELOR®
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).

On completing this course students will have acquired the following skills and abilities:

Know the advances that have given rise to modern industrial chemistry. Familiarize with the economic and environmental implications of industrial processes of an inorganic nature, as well as the necessary adaptations to minimize their environmental impact. Know the most important raw materials and inorganic chemicals and their uses. Be able to distinguish the main stages that make up a modern industrial process. Demonstrate general and basic knowledge that allows the student to manage in the chemical industries in general and those of traditional and advanced ceramic. Be able to design a ceramic product with specific properties.

DESCRIPTION OF CONTENTS

1. Introduction

Introduction. Inorganic chemicals industry. Historical perspective. Chemicals: classification. Economic aspects of the chemical industry. Raw Materials. Industrial processes (batch and continuous). Main differences between a chemical process at the laboratory level and at the industrial scale. Ecology and sustainability.

2. Primary inorganic materials.

Water. Drinking water. Disinfection of water. Separation of insoluble contaminants (mechanical separation). Separation of soluble contaminants (physical-chemical and biological treatment). Production of drinking water from sea water (desalination). Composition of the air. Oxygen. Noble gases. Hydrogen. Hydrogen peroxide and inorganic peroxides. Production, uses and economic importance.

3. Nitrogen and its compounds.

Fertilizers (composition). Ammonia. Nitric acid. Emissions of nitrogen oxides. Ammonium derivatives. Hydrogen cyanide. Hydrazine. Hydroxylamine. Urea. Production, uses and economic importance.

4. Phosphorus and its compounds

Phosphorus. Phosphoric acid. Phosphates. Eutrophication. Phosphorus halides and their derivatives. Esters. Production, uses and economic importance.

5. Sulfur and its compounds.

Sulfur. Sulfur dioxide. Sulfuric acid. Emissions of sulfur oxides. Calcium sulfate.

6. Halogens and their compounds.

Hydrogen fluoride. Sodium chloride. Chlor-alkali industry. Hydrogen chloride. Oxygen compounds of chlorine. Production, uses and economic importance.

7. Carbon and its compounds

Carbon. Sodium carbonate. Carbon black. Emissions of carbon dioxide (separation and treatment). Production, uses and economic importance.

8. Titanium dioxide

Titanium dioxide. Alternatives to rutile. Production, uses and economic importance.

9. Silicon and its oxides

Silicates. Silicon (obtaining, purification and crystallization). Silicones. Production, uses and economic importance.

10. Introduction to the ceramic materials and the ceramic industry.

Concept of ceramic material and ceramic. The ceramic industry. Ceramic processes. Raw materials. Molding and cooking. Melting and solidification. Special processes. Ceramic Products. Traditional Pottery. Technical ceramics.

11. Techniques for the preparation of ceramic materials.

Conventional techniques for the preparation of ceramic materials. Shaping methods. Solid state reactions. Experimental technique. Other non-conventional preparation techniques. Drying techniques. Sol-gel techniques. Other chemical pathways to prepare materials. Collation and ion-exchange techniques. Vapour phase transport technique. Techniques for the preparation of monocrystals.

12. Techniques for characterization of ceramic materials.

Concept of structure in the characterization of ceramic materials. Types of techniques used. Diffraction techniques. Powder Diffraction of x-rays. Powder diffractometry. Microscopic techniques. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Spectroscopic techniques. Thermal Analysis. Applications of the differential thermal analysis and thermogravimetric analysis.

13. Crystalline Structure and crystallochemistry of ceramic materials

Description of crystal structures. Model of compact packing. Model of Polyhedra taking up space. Interesting structures common in ceramic materials. Structures 1:1. Structures 1:2. Structure of silicate. Other structures: spinel, perovskite etc. factors that influence the formation of crystalline structures

14. Phase Diagrams of ceramic materials

Definitions. One-component systems. Two-component systems. Simple eutectic systems. Binary systems with compounds. Binary systems with liquid immiscibility. Solid solutions. Binary systems with solid solutions. Phase transitions. Binary systems with solid-solid transitions. Ternary systems. Subsolidus equilibria. Ternary systems containing binary compounds. Ternary systems with formation of ternary compounds. Ternary systems with solid solutions. Examples of binary and ternary systems in advanced and traditional ceramics. CaO-SiO2 system. MgO-Al2O3-SiO2 system.

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 must have previously worked on. Logically, these classes must be complemented with individual study.

Group tutorials. Small groups of students attend these sessions in which the lecturer proposes questions or problems. Also, queries will be solved and topics that are relevant to the subject will be discussed.

EVALUATION

The knowledge acquired by students will be graded on an examination on the date established by the Faculty. The exam will consist of objective questions covering basic knowledge, numerical problems and questions that involve the application of the different concepts presented in the units that make up each of the two parts of the subject. To pass the course, students must obtain at least 5 points out of 10 in each of the two parts of the subject. Students who do not pass the first call must sit the second examination, which follows the same structure and marking scheme.

REFERENCES

Basic

- Büchel, K.H.; Moretto,H.H.; Woditsch, P. Industrial Inorganic Chemistry, 2ª Ed., Wheinheim: Wiley-VCH,2000. ISBN:978-3-527-29849-5

- Ayres, R. U.; Ayres,L. W. Industrial Ecology, 1ª Ed. Cheltenham: Edward Elgar, 1996. ISBN: 978 1 85898 397 4
- Kingery,W. D.; Bowen, H. K. & Uhlmann, D. R. Introduction to ceramics. 2ª Ed. John Wiley & Sons, 1975. ISBN: 978-0-471-47860-7
- Segal,D. Chemical synthesis of advanced ceramic materials,1ª Ed. Cambridge: Cambridge University Press, 1989. ISBN: 9780521424189
- Institute for Prospective Technological Studies Reference Documents (http://eippcb.jrc.ec.europa.eu/reference/)

ADDENDUM COVID-19

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

English version is not available