COURSE DATA

Data Subject	
Code	36462
Name	Polymers and colloids
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

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

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	15 - Physical Chemistry Applied	Optional

Coordination

Name	Department
MUÑOZ ESPI, RAFAEL	315 - Physical Chemistry

SUMMARY

The course “Polymers and Colloids” is an optional subject of 6.0 ECTS credits, taught during the second semester of the 4th year in the bachelor studies. The course aims to integrate in the chemical training of the student basic concepts related to polymeric and colloidal materials.

From a didactic point of view, the contents of the course have been distributed in three blocks: polymers, colloids, and applications. The first block focuses on polymeric materials from a general point of view. The second block deals with colloidal systems, with a special emphasis on polymer colloids. The different didactic units of these first two blocks cover (i) the synthesis of the materials, (ii) the physico-chemical aspects related to polymer and colloid systems, and (iii) the characterization techniques. The third and last block, shorter in extension, has a single didactic unit and aims to give concrete examples of applications of polymers and colloids.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

OUTCOMES

1110 - Degree in Chemistry

- Develop capacity for analysis, synthesis and critical thinking.
- Show inductive and deductive reasoning ability.
- Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation.
- Solve problems effectively.
- Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.
- Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate.
- Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.
- Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.
- Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units.
- Demonstrate knowledge of the characteristics and behaviour of the different states of matter and the theories used to describe them.
- Demonstrate knowledge of the main types of chemical reaction and their main characteristics.
- Show knowledge of the metrology of chemical processes including quality management.
- Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids and other materials.
- Show knowledge of the structure and reactivity of the main classes of biomolecules and the chemistry of the main biological processes.
- 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.

- Evaluate, interpret and synthesise chemical data and information.
- Handle the instrumentation used in the different areas of chemistry.
- Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them.
- Relate theory and experimentation.
- Recognise and evaluate chemical processes in daily life.
- Understand the qualitative and quantitative aspects of chemical problems.
- Develop sustainable and environmentally friendly methods.
- 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.
- 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 POLYMERS AND COLLOIDS 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 POLYMERS AND COLLOIDS 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 POLYMERS AND COLLOIDS that contemplate the learning

	outcomes EUROBACHELOR®
Major aspects of chemical terminology, nomenclature, conventions and units.	Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units..(CE1)
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 investigations, including spectroscopy	Ability to recognise chemical elements and their 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 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).
The relation between bulk properties and the properties of individual atoms and molecules, including macromolecules (both natural and man-made), polymers and other related materials.	Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids and other materials.CE11).

COMPETENCES AND COGNITIVE SKILLS	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject POLYMERS AND COLLOIDS 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).
Competences for the evaluation, interpretation and synthesis of information and chemical data.	Evaluate, interpret and synthesise chemical data and information..(CE16). Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them..(CE20).
Ability to recognize and implement science	Show knowledge of the metrology of chemical processes including quality management..(CE10)

and the practice of measurement.	Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them..(CE20).
Competences to present and argue scientific issues orally and in writing to a specialized audience.	Relate chemistry with other disciplines.(CE26). Prepare reports, surveys and industrial and environmental projects in the field of chemistry..(CE27). Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate. (CG6). Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences..(CB4).
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 POLYMERS AND COLLOIDS 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).
Calculation and arithmetic capabilities, including aspects such as analysis error, estimates of orders of magnitude, and correct use of the units.	Develop capacity for analysis, synthesis and critical thinking.. (CG1). Show inductive and deductive reasoning ability..(CG2). Solve problems effectively..CG4).
Competences in information management, in relation to primary and secondary sources, including information retrieval through on-line searches.	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.(CT2).
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).
Ability to adapt to new situations and make decisions.	Demonstrate the ability to adapt to new situations..(CG9). Recognise and analyse new problems and plan strategies to solve them..(CE15). 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.(CT2).
Planning and time management skills.	Develop capacity for analysis, synthesis and critical thinking. (CG1). Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation..(CG3). Solve problems effectively..CG4).

Interpersonal skills to interact with other people and get involved in team work.	Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Demonstrate the ability to adapt to new situations..(CG9).
Competences in oral and written communication, in one of the main European languages, in addition to the language of the country of origin.	Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community. (CT1). Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences..(CB4). Have basic skills in the use of information and communication technology and properly manage the information obtained.(CT2).
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).
Ethical commitment to the European Code of Conduct: http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf	Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.(CG10). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). 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).

Regarding the Sustainable Development Goals (SDGs), it is expected that students will be able to know in this subject how to acquire a special sensitivity for sustainable management of water (SDG 6), raw materials and energy sources (SDG 7) as well as sustainable development compatible with the environment (SDGs 11, 12, 13, 14 and 15).

These learning outcomes are to allow that, at the end of the course, the student should be able to:

Unit 1

- Define polymer or macromolecule.
- Define the size of a polymer and differentiate the characteristic average molecular masses of macromolecular systems.
- Differentiate the characteristic temperatures of a polymer.
- Explain the variation of the state of a polymer as a function of temperature.

Unit 2

- Describe the types of polymerization reactions.
- Describe the polymerization kinetics.
- Explain the preparation of a polymer by chain polymerization method.
- Explain the preparation of a polymer by the step-polymerization method.
- Compare the polymerization techniques.

Unit 3

- Define glass transition temperature.
- Explain which factors the glass transition temperature depends on.
- Explain polymer crystallization.
- List which factors affect the crystallization.
- Define melting temperature.
- Cite which factors affect the melting temperature.
- Explain the variation of the state of a polymer as a function of temperature.
- Explain the behavior of a polymer under a strain as a function of temperature.

Unit 4

- Characterize polymers in solution.
- Determine average molecular weights
- Characterize polymers in solid and molten states.
- Evaluate the properties as a function of temperature.
- Evaluate the behavior based on applied force.
- Evaluate the properties of structure and morphology in polymers.

Unit 5

- Differentiate colloidal and non-colloidal systems according to the IUPAC definition
- Classify colloidal systems according to the different possible criteria.
- List and describe the different methods of colloid preparation.
- Explain the techniques of preparation of inorganic colloids.
- Describe the main aspects of the processes of nucleation and growth in colloids.

Unit 6

- Define the concept of surfactant and classify the different types.
- Explain the adsorption of surfactants in interfaces using thermodynamic concepts.
- Define the concepts of micelle and critical micelle concentration.
- Describe the concept of number of aggregation and relate it to the possible aggregation structures in colloidal systems.
- Evaluate the suitability of a surfactant as an emulsifier of a given system according to its value of

HLB index.
- Explain the fundamental thermodynamic aspects of interfaces in colloidal systems.
- Describe the double layer models for charged interfaces applied to colloidal systems.
- Explain processes of interaction between particles, taking into account the concepts of electrostatic and steric stabilization.
- Explain and apply the DVLO theory in the evaluation of colloidal stability.

Unit 7

- Differentiate the types of emulsion (emulsion, miniemulsion and microemulsion) according to their thermodynamic and kinetic characteristics.
- List the most common methods of homogenization in emulsions and describe the fundamental aspects of each one.
- Differentiate the types of polymerization in heterophase systems and describe the main characteristics of each.
- Cite examples of polymerization in systems with spontaneous emulsification.
- Explain the technique of preparing polymer colloids by solvent evaporation.

Unit 8

- Describe and evaluate the limitations of the usual techniques of characterization of particle size in colloidal systems.
- Describe and evaluate the limitations of the usual characterization techniques of morphological and structural characterization of colloidal systems
- Predict the stability of a colloidal system according to zeta potential values and evaluate the limitations of the prediction.
- Demonstrate ability to select the appropriate method to the type of chemical problem and know the expected errors.

Unit 9

- Demonstrate the ability to correlate the knowledge acquired in chemistry and through bibliographic information to the physicochemical processes that occur in the laboratory and at industrial level.
- Demonstrate capacity, based on the application of physicochemical knowledge, to innovate in productive processes.
- Demonstrate the ability to solve real problems that require a multidisciplinary and theoretical practical study, combining several physicochemical techniques.
- Demonstrate the ability to explain through physicochemical theoretical phenomena real situations that take place during the synthesis and characterization of materials, both in the laboratory and in industrial processes.

DESCRIPTION OF CONTENTS

1. Polymers and polymer systems

1.1. General aspects and historical development of macromolecular chemistry
1.2. Classification of polymers and copolymers
1.3. Molecular weight distributions
1.4. Conformation, configuration, and polymers in solution
1.5. Polymer nomenclature

2. Polymerization reactions

2.1. Introduction: classification of polymerization reactions
2.2. Chain-growth polymerization
2.2.1. Radical polymerization
2.2.2. Anionic polymerization
2.2.3. Cationic polymerization
2.3. Step-growth polymerization
2.4. Differences between chain-growth and step-growth polymerization
2.5. Polymerization methods

3. Properties of polymers in solid state

3.1. Polymers in the solid state: amorphous and crystalline states
3.2. Glass transition temperature and melting temperature
3.3. Amorphous polymers
3.4. Semicrystalline polymers: polymer crystallization

4. Polymer characterization

4.1. Characterization of polymers in solution: determination of molecular weights and dimensions
4.2. Characterization of polymers in the solid state: thermal analysis
4.2.1. Thermogravimetric analysis (TGA)
4.2.1. Differential scanning calorimetry (DSC)
4.2.1. Dynamic mechanical analysis (DMA)
4.3. Characterization of mechanical properties
4.4. Other useful techniques for polymer characterization

5. Colloid Systems

5.1. Definition of colloid
5.2. Historical aspects of the development of the colloid and interface science
5.3. Classification of colloidal systems
5.4. Particles in dispersion
5.5. Emulsions
5.6. Inorganic colloids
5.7. Precipitation reactions and particle formation: nucleation and growth
5.8. Sol-gel processes
5.9. Microemulsion and miniemulsion for the formation of inorganic nanoparticles

6. Interfaces in colloidal systems and colloidal stability

6.1. Surfactants
6.1.1. Definition and classification
6.1.2. Adsorption of surfactants and thermodynamic aspects
6.1.3. Formation of micelles and other aggregation structures
6.1.4. Practical criteria for choosing surfactants: hydrophiliclipophilic balance (HLB)
6.1.5. Detergency
6.2. Physical stability of colloids
6.2.1. Stability in colloids and stabilization strategies
6.2.2. Sedimentation
6.2.3. Interaction between particles: aggregation and flocculation
6.2.4. DLVO theory and electrostatic stabilization
6.2.5. Steric stabilization
6.2.6. Ostwald ripening
6.2.7. Coalescence

7. Polymer colloids and heterophase polymerization

7.1. Types of emulsions and homogenization methods in emulsions
7.2. Polymerization in heterophase systems
7.3. Preparation of polymer colloids by spontaneous emulsification
7.4. Preparation of polymer colloids by solvent evaporation techniques

8. Colloid characterization

8.1. Size characterization
8.2. Morphological and structural characterization
8.3. Characterization of the stability of colloidal systems
8.4. Characterization of other physical parameters

9. Applications of colloid and polymer systems

9.1. Examples of current applications of polymers
9.2. Examples of current applications of colloidal systems

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	51,00	100
Tutorials	9,00	100
Development of individual work	30,00	0
Study and independent work	32,00	0
Preparing lectures	14,00	0
Preparation of practical classes and problem	14,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The development of the subject is done through three types of on-site teaching sessions: theory classes, tutorials, and seminars.

In the theory classes, the fundamental concepts of each unit of the teaching guide will be explained, indicating the relevant literature for the consolidation of the topic. In addition, students will have teaching materials provided by the teaching team, which can serve as a starting point for the student's work, but never as the only study material. After exposing the theoretical concepts, practical activities corresponding to the theme will be carried out.

In the tutorial sessions, the students will work on practical activities proposed by the teacher, a part of them available in advance to allow their autonomous resolution and facilitate the active participation. The tutorials will be interactive to allow the resolution of the doubts of the students.

Finally, theoretical-practical seminars are planned for deepening of aspects of certain topics, highlighted by their interest or actuality. The seminars may be taught or moderated by the teacher or by other professionals relevant to the topic covered and involve the participation of the students by completion of critical exercises, debates, or presentations, and practical activities of different character. The exact date of the seminars, within the official time schedule of the subject, will be announced during the first days of the course.

EVALUATION

The evaluation of the student's learning will take into account all aspects exposed in the methodology section of this teaching guide. As a general rule, the evaluation will be trough continuous assessment in the classroom. Exceptionally, for students that cannot attend classes because of justified reasons, we offer an only-exam modality. By default, all students remain assigned to the continuous-assessment modality, unless that a written application is submitted to professors of the subject, including the reasons and documents that justify the impossibility to attend the normal lectures. This application has to be submitted within the first 30 days from the beginning of the course. If the only-exam modality is not requested and the face-to-face session have not been attended, the continuous assessment will not be passed and the subject will be automatically considered as failed.

Continuous-assessment modality. This modality takes into account the student's continuous assessment, which will weigh 40%in the final grade. Delivery of activities, active participation in tutorials and seminars (16 hours in total), and continuous assessment tests (CAT) will be taken into account in the continuous evaluation. Continuous assessment tests (CAT) will be carried out during tutorial and seminar sessions. The participation of the student in the sessions of group tutorials and seminars is mandatory. To compensate the non-assistance to a mandatory session, always for a documented justified exceptional reason, the teaching staff may propose the completion of alternative activities. In any case, continuous assessment tests conducted during tutorial and seminar session cannot be retaken. Missing 5 or more hours of tutorials and seminars will automatically imply the grade "not passed" in the continuous assessment with 0% and, consequently, the subject will be failed. The remaining 60% of the grade will be the result of a final assessment test (FAT) with theoretical and/or practical exercises. To pass the subject the student must obtain a total grade equal to or greater than 5 (over 10). It will also be necessary to reach a minimum score of 40% of the total of the section in each of the sections considered in the evaluation.

Exceptional only-exam modality. In the only-exam modality, the final grade corresponds exclusively to the exam. To pass the subject the student must obtain a total grade equal to or greater than 5 (over 10).

The evaluation system will be the same in the two calls. If applicable, the continuous assessment grade is maintained for the second call.

REFERENCES

Basic

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Additional

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