Universidad Zaragoza

Academic Year/course: 2021/22

25263 -

Syllabus Information

Academic Year: 2021/22
Subject: 25263 - Química sostenible y medioambiental
Faculty / School: 201 - Escuela Politécnica Superior
Degree: 571 - Degree in Environmental Sciences
ECTS: 6.0
Year: 3 and 4
Semester: First Four-month period
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

This course is designed to go deeper in understanding the properties and reactions of substances (especially anthropogenic chemicals) in the environment and to introduce students to the principles of sustainable chemistry.

In addition, students are expected to become familiar with the experimental work of chemistry laboratory and to be able to independently and critically search for information related to the area of study and present it in an appropriate manner, both orally and writing.

These objectives are in line with some of the Sustainable Development Goals (SDGs) of the 2030 Agenda and certain specific goals (https://www.un.org/sustainabledevelopment/en/), contributing to some extent to their achievement:

Goal 4: Quality education	
Target 4.7	*By 2030, ensure that all learners acquire the knowledge and skills needed to **promote sustainable development**, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture?s contribution to sustainable development.*
Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all	
Target 8.4	*Improve progressively, through 2030, **global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation**, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead.*
Goal 12: Ensure sustainable consumption and production patterns	
Target 12.2	*By 2030, achieve the **sustainable management and efficient use of natural resources**.*
Target 12.4	*By 2020, achieve the environmentally sound management of **chemicals** and all **wastes** throughout their **life cycle**, in accordance with agreed international frameworks, and significantly reduce their **release to air, water and soil** in order to minimize their adverse impacts on human health and the environment.*
Target 12.5	*By 2030, substantially reduce waste generation through **prevention, reduction, recycling and reuse**.*

1.2. Context and importance of this course in the degree

In the curriculum of the degree of Environmental sciences, there is only a subject of general chemistry

(1st year, 6 ECTS), where only a lesson is dedicated to "Carbon compounds: introduction to hydrocarbons and functional organic groups". In other subjects, aspects of environmental chemistry and/or chemistry for the environment (pollution remediation methods, etc.) can be seen. However, it is important for graduates to have deeper knowledge about pollution derived from the chemical industry (plastics, surfactants, pesticides, hydrocarbons, etc.): transportation, transformations, destinations, etc. It is also essential that they have notions of how chemistry itself, through the tools provided by sustainable chemistry, can provide solutions to the environmental problems that it generates. This optional subject contributes to the aforementioned.
If we imagine a matrix of easements, we can say that this course is basically, served by ?Chemical foundations of the environment? and ?Environmental science and sustainability? (both 1st year).
On the other hand, this subject can be an excellent complement to ?Atmospheric pollution? (2nd year), ?Soil degradation and pollution? (2nd year), ?Water pollution? (3rd year) and ?Management, treatment and recovery of waste? (3rd year), all of them compulsory courses. It is also possible to establish a synergy relationship with the mandatory course ?Clean technologies. Renewable energies? (3rd year).
Finally, the competences acquired in this subject can be of help in other courses, such as ?Environmental impact assessment? (compulsory, 4th year), as well as, for the ?Undergraduate dissertation? (4th year).

1.3. Recommendations to take this course

Students are expected to participate actively in the class throughout the semester.

This subject is offered in the English Friendly form.

2. Learning goals

2.1. Competences

Basic competences:

CB1. That students have shown that they possess and understand knowledge in the area of environmental sciences based on general secondary education, which tends be at a level that, even with the use of advanced textbooks, also includes certain aspects that involve avant-garde knowledge in their field of study.
CB2. That students know how to apply their knowledge to their work or vocation professionally and possess skills that tend to be shown by the elaboration and defence of arguments and problem-solving within their area of study.
CB3. That students have the capacity to bring together and interpret relevant data (normally within environmental sciences) in order to make decisions that include a reflection on socially, scientifically or ethically relevant subjects.
CB4. That students can transmit information, ideas, problems and solutions to both an expert and non-expert audience.
CB5. That students have developed the learning skills necessary to undertake subsequent studies with a high degree of autonomy.
Specific competences:

CE1. Capacity to interpret the environment as a complex system: identification of factors, processes and interactions that include any type of environment. This entails fundamental knowledge in all systems (hydrology, edaphology, meteorology and climatology, zoology, botany, geology, society and territory, etc.), understanding their formation and fundamental processes (physical, chemical and biological) and their interactions (ecology).
CE2. Capacity of multi-disciplinary analysis of indicators and evidence of an environmental problem or situation, with the capacity of qualitative and quantitative interpretation of data coming from diverse specialties, capacity in giving an analysis with theoretical models and awareness of time and space dimensions of the environmental processes involved.
CE3. Mastery of processes, languages, techniques necessary for the interpretation, analysis and evaluation of the environment. This entails the knowledge of math basics, statistic procedures and programs, mapping and geographic information systems, instrumental analysis systems in the environment or basics of environmental engineering.
CE11. Capacity to design and apply environmental indicators and sustainability strategies.
Generic competences:

CG1. Comprehension and mastery of fundamental knowledge in the area of study and the ability to apply this fundamental knowledge to specific tasks of an environmental professional.
CG2. Communication and argumentation, oral and written, of stances and conclusions, to expert audiences or broadcasting and information to non-expert audiences
CG3. Capacity to solve problems, both generic ones and ones typical of the area, using the interpretation and analysis of relevant data and evidence, the issuing of evaluations, decisions, reflections and pertinent diagnoses, with the consideration suitable to scientific, ethical or social aspects.
CG4. Capacity of consistent decision-making.
CG5. Capacity of critical reasoning (analysis, synthesis and assessment).
CG6. Capacity to apply theoretical knowledge to an analysis of situations.
CG7. Mastery of IT applications related to the field of study, as well as the use of the internet as medium and source of information.
CG8. Capacity to autonomously organize and plan work and manage information.
CG9. Capacity to work on a team, in particular tams of an interdisciplinary and international nature typical of the work in this field.
CG10. Capacity to lead, to organize working teams and fundamental skills in interpersonal relationships.
CG11. Capacity of communication, argumentation and negotiation both with specialists of the area as well as non-experts on the subject.
CG12. Ethnical commitment to all aspects of one?s professional performance.
CG13. Capacity of autonomous learning and self-assessment.
CG15. Capacity to adapt to new situations.
CG17. Sensitivity towards environmental themes.

2.2. Learning goals

On successful completion of the course, students will be able to:
1. Name and recognize the most **important chemical pollutants** coming from human activity and, especially, from the **Chemical Industry**.

2. List, describe and quantify the different **mechanisms of transport and fate** in the environment of the most common chemical substances from human activity.
3. List, describe and quantify the most important chemical, photochemical and biological **transformations** that pollutants can suffer.
4. Indicate the **beneficial or harmful effects** that the chemical, photochemical and biological transformations of the chemical substances emitted, have on the environment.
5. Identify and describe the **principles and tools offered by sustainable chemistry** to reduce the environmental impact of human activities.
6. Name and recognize the chemical substances that cause the greatest **environmental impact** and evaluate their possible **substitution** in order to develop environmentally more sustainable processes.
7. Identify and select the **appropriate material** for conducting experiments in the laboratory and use it correctly.
8. Compile and interpret in an organized and critical way the results obtained in the **laboratory experiments**.
9. Develop **group work** in which it collects and organizes the information in an autonomous way and present it in an appropriate way, both orally and in writing.
10. To become familiar with the **Sustainable Development Goals** (**SDGs**) proposed by the United Nations in the 2030 Agenda, while identifying existing relationships with the aspects covered in the course.

Learning goals	SDG	Target
1 to 6 and 9 to 10	**4**	***4.7***
1 - 5 - 6 - 10	**8**	***8.4***
1 - 5 - 6 - 10	**12**	***12.2***
1 - 4 - 5 - 6 - 10	**12**	***12.4***
1 - 5 - 6 - 10	**12**	***12.5***

2.3. Importance of learning goals

These learning goals contribute to the better knowledge of the chemical substances and processes more related to the study of the environment. On the other hand, they bring the student closer to the solutions offered by sustainable chemistry to avoid or minimize the environmental impact of chemical substances and processes. In addition, they allow the student to know the fundamental aspects of working in a chemistry laboratory and also to promote autonomous and teamwork, etc.
They familiarize the students with the SDGs, mainly through tutored works and proposed activities (seminars, visits, etc.).
All the above will be of great help to successfully face other courses of the degree and also for the future career.

3. Assessment (1st and 2nd call)

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

The student must demonstrate that they have achieved the expected learning outcomes through the following assessment activities.
Continuous evaluation is carried out. However, students will also have the option to take the global test according to the EPS exam schedule for the two official calls. The student must do on the global

test on first call (and/or second) those activities that they have not passed through continuous evaluation (and/or on the global test on first call), and may voluntarily choose to repeat those activities whose grade want to improve. In the latter case, the grade that most benefits the student will be awarded.
The activities and evaluation criteria of the continuous evaluation and the global test (first and second call) are described below (see also summary table).

Continuous assessment

1. **Theory exam (TE)** (30% of the FG)
They consist of test-type questions, true-false questions and/or short answer questions, etc.
2. **Problem exam (PE)** (20% of the FG)
3. **Academic project (AP)** (25% of the FG)
Realization and presentation of a group work (the individual accomplishment in justified cases will be able to be considered) on topics related to the subject. It is a guided work so the tutor through personalized tutoring sessions, tasks to be delivered, etc, will carry out a follow-up.

? Final job (50%)

? Oral presentation (50%)

Although the execution of the work is carried out in groups, its members may obtain different grades, depending, for example, on the different tasks to be carried out individually, and using tools such as self-assessment and hetero-evaluation among students.
4. **Laboratory sessions** (LS) (25% of the FG)
4.1. Previous questions of each session (30%)
With the aim of ensuring a good preparation of the session, students have to take a writing short exam consisting in several questions regarding the corresponding practice during the first 15 minutes of each session.
4.2. Final practice exam (70%)
The good use of the practice sessions must be demonstrated.
It will include questions about the theoretical foundations, as well as the experimental procedures of the practices and questions about material, laboratory equipment, safety regulations and the proper functioning of a chemical laboratory.
If the students choose the continuous evaluation of the practices, they must attend at least 80% of them. No attending to one of them implies a grade of zero in the previous questions.
5. **Complementary activities (CA)** (up to 1.0 extra point on FG)
The activities (visits, seminars, debates, etc.) that can be proposed on a voluntary basis may involve an extra note on the final grade of the subject of up to a maximum of 1 point.

Intermediate exams may be proposed that eliminate subject matter for the exams described which, in principle, are scheduled for the end of the semester class period. The weight of these intermediate exams will be adjusted in each case. On the other hand, the dates of the presentation and defense of the work will be advanced as much as possible.

Overall evaluation (100% of the FG)
It is made up of the following parts (See summary table):
1. **Theory exam (TE)** (30%)

2. **Problem exam (PE)** (20%)
3. **Academic project (AP)** (25%)
In the event that a group/student takes this test without having participated during the semester of the different tasks derived from the tutoring of the work, they must present the work on a topic related to the subject, as long as it has been agreed with teachers with a reasonable enough time communication (50%). Teachers and students will agree on the time to defend the work in this last case, for the same day of the global test, or for another day as close as possible (50%).
4. **Theoretical-practical exam of the laboratory sessions (LS)** (25%)
Similar to the final practice exam of the continuous assessment.

Thus, the **overall grade** (GG) of the subject will be the sum of the extra mark derived from the complementary activities and the **final grade** (FG), calculated the latter as the weighted average of the described assessment activities (all of them rated out of 10), according to the indicated percentages. The **extra points** mentioned **will only be added to the FG if it is greater than or equal to 4 points out of 10**, both in the first and second calls. The GG never will exceed the numerical rating of 10. (See summary table).

The following table summarizes the different tests and evaluation criteria of the subject:

ASSESSMENT (system)*	**Final grade (FG)****	**Observations**
1. Theory exam (TE) multiple-choice questions true-false questions short answer questions, etc.	**30%**	Same continuous** and global assessment.
2. Problem exam (PE)	**20%**	
3. Academic project (AP) preferably group work	**25%**	Same continuous and global assessment: Work: 50% Oral presentation and debate: 50%
4. Lab sessions (LS) lab sessions (exams)	**25%**	Continuous assessment:*** Individual questionnaires before each lab session (30%) Final exam (70%)**
		Global assessment: Exam (100%)
5. Complementary activities (CA)		Voluntary activities that may add up to 1 point, to be added to the FG.
$FG = 0.3\ G_{TE} + 0.2\ G_{PE} + 0.25\ G_{AP} + 0.25\ G_{LS}$		
GG** = FG + EXTRA POINTS (CA)**		

* All tests are scored on 10 points.
** Intermediate exams may be considered that eliminate material. The weight of these intermediate exams will be adjusted to each case.
*** If students opt for the continuous evaluation of the practices they will have to attend at least 80% of them. No attending to one of them implies a grade of zero in the previous questions.
*** The global grade (GG) will result from the addition to FG of the extra grade (up to 1 point), obtained from the complementary tasks carried out on a voluntary basis. These will only be added if FG is equal to or greater than 4, in both calls.

In the evaluation of the tests described, the accuracy, rigor and approach of the answers will be positively valued, as well as the argumentation and critical analysis of the same. Likewise, the

understanding of concepts and processes, and the ability to interrelate them, as well as concretion, clarity, order and presentation will be valued.
In addition, in the case of the academic project, the treatment of the information (bibliography and documentation) and the good use of a method of citations and references will be evaluated. Likewise, the originality of the chosen topic, the correct approach, the rigor of the contents, clarity, good expression, quality of the presentation and the knowledge about the topic will be positively valued. The group work skills and the different tasks to be delivered related to the tutoring of the work will also be considered.
Likewise, in general, the identification, integration and linkage of the theoretical and practical concepts of the subject with the objectives and goals of the 2030 Agenda aligned with this discipline will be favorably valued.

SDG (Target)	Test type	% of Final Grade (FG)
4 (4.7)	Theory exam Problems exam Academic project Lab sessions	30 20 25 25
8 (8.4)	Theory exam Problems exam Academic project Lab sessions	30 20 25 25
12 (12.2) (12.4) (12.5)	Theory exam Problems exam Academic project Lab sessions	30 20 25 25
Additionally, the complementary activities (CA) that may be proposed may involve up to a maximum of 1 point over the final grade (FG).		

If plagiarism or other fraudulent actions are detected and confirmed, it will be sufficient reason for the qualification with the lowest possible grade of the corresponding test.

The evaluation of this subject is planned to be carried out face-to-face, whenever possible. Otherwise, and following the guidelines set out if the case, the evaluation activities will be adapted to enable them to be carried out remotely, trying to maintain, as far as possible, the typology and criteria set out here.

Student are allowed to consult bibliography during the exams (excluding web pages or similar)
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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, problem-solving, laboratory sessions, academic projects, autonomous work and study and assessment tasks.
Lastly, complementary activities (visits to sites of interest for the subject, viewing videos, raising debates, commenting on articles and news, holding seminars, etc.) will be carried out, as far as possible, to help students to relate the theoretical and practical contents of the subject with reality and

bring them closer to possible professional scenarios.
Classroom materials and further information regarding the course will be available via Moodle.

4.2. Learning tasks

This is a 6 ECTS course organized as follows:
Lectures. The theoretical sessions consisting mainly in participatory lectures, which are designed to provide the students with knowledge about the chemistry and evolution of different pollutants in the environment, as well as an introduction to Sustainable chemistry. It will be encouraged an interactive environment that will be used to discuss and reinforce the lecture contents.
Problem-solving sessions. The proposed problems may be discussed in group. This activity complements the contents presented in lectures by problem-solving sessions. A very active participation of the students in the sessions will be promoted. The proposed problems may be discussed in group.
Lab sessions. During these sessions, students learn to handle laboratory equipment to conduct experiments. This activity requires autonomous study of the protocols and instructions for planned activities before going to the lab. Student will complete individual questionnaires just before starting in the lab.
Academic project. This activity requires the student to work preferably in groups on a topic related to environmental and sustainable chemistry that extends the contents of lecture and necessarily in previous agreement with the professor, and finally they will elaborate a written report (for example, poster format) and present orally the most relevant of it, opening a short discussion on the topic afterwards. The tutor will give the student regular feedback on progress. In addition, the project requires the student to construct logical arguments to communicate effectively.
Complementary activities (when possible). Visits to places of interest for the course, videos viewing, debates, comment on articles and news, conduct seminars-conferences on specific issues of particular relevance, etc.
Debates
Tutorials
Autonomous work and study
Assessment tasks

4.3. Syllabus

The course will address the following topics:
Lectures

Topic 0. General issues about the course.
MODULE I. Environmental chemistry.
Lesson 1. Environmental performance of pollutants: Transportation and/or accumulation.
Lesson 2. Abiotic transformation and biotransformation of pollutants.
Lesson 3. The impact of the chemical industry on the environment.
Lesson 4. Pollutants originating from the chemical industry and their environmental (degradation, accumulation and effect): surfactants, metallic compounds, hydrocarbons [petroleum, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), dioxins (PCDD), dibenzofurans (PCDF), polybrominated diphenylethers (PBDE)], polymeric materials and pesticides.

MODULE II. Sustainable chemistry.

Lesson 5. Basic principles and tools of Sustainable chemistry.

Note: The Topic order displayed above might vary according to educational or organizational needs.

Lab sessions

1. Acid-base nature of organic compounds.
2. Preparation of biodiesel and comparison of residues generating biodiesel combustion against those of a more typical fuel.
3. Biotransformation.
4. Preparation of biodegradable polymers.
5. Comparison of reactions occurring either with or without solvent.

Note: The practical activities order might vary according to educational or organizational needs.

SDG (Target)	Methodology	Learning activity	Program
4 (4.7)	Theory session Conferences Learning based in problems Cases of study Oral presentation Laboratory Tutorials Assignments Practice works Complementary activities Assessment	Lectures Practice sessions (problems) Lab sessions Academic visits Group work Tutorials Autonomous work Assessment	Lessons 1 and 5 Lab sessions
8 (8.4) **12** (12.2) (12.4) (12.5)			Mainly lessons 4 and 5 Lab sessions 2 - 5

4.4. Course planning and calendar

The student must dedicate 150 hours (6 ECTS) including 60 hours (approx.) of face-to-face activities, and the rest of autonomous work and study. Those are scheduled as follows.

Provisional course planning:

Activity / Week	1	2	3 (1)	4	5	6(2)	7	8	9	10(3)	11	12	13	14	15
Face-to-face															
Introduction		0,5													
Lectures		2	3,5	1		2	2,5	1	2,5	3,5	3	1		2,5	1
Seminars/otros		1					1,5				1				
Problem seminars			1,5			2			1,5					1,5	
Lab sessions				3		3		3				3			3
Academic Project		0,5								1,5					
Academic Project office hours				0,5			0,5		1						

Academic visit											3				
Examination															
Autonomous work															
Individual work		4	4	3	8	2	3	3	3	3	3	5	8	5	5
Group work				1		1	1	1	1	1					
TOTAL	0	8	9	8,5	8	10	8,5	8	9	9	10	9	8	9	9

(1) 1st October as Monday

(2) 22th October as Tuesday

(3) 18th November as Monday

(4) 10th January as Friday

(5) 11st January as Friday

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 EPS website and Moodle.

The teaching of this subject is planned to be carried out mainly face-to-face, whenever possible. Otherwise, and following the guidelines set out if the case, the learning activities will be adapted to enable them to be carried out remotely, trying to maintain, as far as possible, the typology set out here.

4.5. Bibliography and recommended resources

BB Domènech, Xavier. Química verde / Xavier Domènech Barcelona : Rubes, 2005

BB Martínez Grau, María Angeles. Técnicas experimentales en síntesis orgánica / Mª Angeles Martínez Grau, Aurelio G. Csákà¿ . [1ª reimpr.] Madrid : Síntesis, D.L. 2001

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BC Baird, Colin. Química ambiental / Colin Baird ; versión española por Xavier Domènech Antúnez . Ed. en español, reimpr. (2004) Barcelona [etc.] : Reverté, D.L. 2004

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BC Hites, Ronald A.. Elements of environmental chemistry / Ronald A. Hites . Hoboken : John Wiley-Interscience, cop. 2007

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BC Manahan, Stanley E.. Environmental chemistry / Stanley E. Manahan . - 8th ed. Boca Raton [etc] : CRC, cop. 2005

BC Manahan, Stanley E.. Fundamentals of environmental chemistry / Stanley E. Manahan . 2nd ed. Boca Raton [etc.] : Lewis Publishers, cop. 2001

LISTADO DE URLs:

Manahan, S.E. (2005). Green chemistry and the ten commandments of sustainability. 2a. ed. Chem Char Research - [http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.674.1894&;rep=rep1&;type=pdf]

For the updated literature please, see here: http://psfunizar10.unizar.es/br13/egAsignaturas.php?id=11006

Non-sexist language. All the names that, by virtue of the principle of economy of language, are made in an inclusive masculine gender in this document will be understood to be made in both feminine and masculine gender.