Universidad Zaragoza

Academic Year/course: 2021/22

25219 - Atmospheric pollution

Syllabus Information

Academic Year: 2021/22
Subject: 25219 - Atmospheric pollution
Faculty / School: 201 - Escuela Politécnica Superior
Degree: 571 - Degree in Environmental Sciences
ECTS: 6.0
Year: 2
Semester: Second Four-month period
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

This course is about get knowledge, training and awareness in

? the main atmospheric pollutants, their sources and their evolution in the atmosphere.

? the different phenomena of atmospheric pollution: photochemical smog, acid rain, global warming, ozone hole, light pollution, noise pollution, etc.

? air quality assessment and analysis of pollutants.

? calculation and prediction of the impact of some sources (dispersion models).

? available techniques for reducing emissions to the atmosphere.

? regulations on issues related to air pollution: air quality, emissions, noise and light pollution, etc.

? negative impact of air pollutants, the need to protect air quality and the implementation of good environmental practices at the individual and collective level.

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 3: Ensure healthy lives and promote well-being for all at all ages	
Target 3.9	*By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and **air**, water and soil **pollution and contamination**.*
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 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation	
Target 9.4	*By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.*
Goal 11: Make cities inclusive, safe, resilient and sustainable	

Target 11.6	*By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to **air quality** and municipal and other waste management.*
Goal 13: Take urgent action to combat climate change and its impacts	
Target 13.3	*Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.*

1.2. Context and importance of this course in the degree

This course aims to provide students with an overview of the complex problem of air pollution. As it is indicated in the section of "Recommendations to take this course", this one uses knowledge acquired in "Chemical foundations of the environment", "Physical foundations of the environment", "Basic mathematics for environment studies" of first year and "Meteorology and climatology" of the second year. Likewise, certain servitude of some subjects is established, such as, "Environmental administration and law" (1st year) and "Toxicology and public health" (3rd year), among others. In addition, "Atmospheric pollution" is complementary to the "Soil degradation and pollution" and "Water pollution", which are taught in second and third years, respectively, within the Environmental assessment module. Likewise, there is a certain complementarity with "Key analysis in the environment", subject of 2nd year, of the Instrumental knowledge module. Passing this discipline will enable students to better understanding of subjects in the Management and environmental planning module, such as "Regional planning and urbanism" and "Environmental management and audit" (third and fourth year), or subjects of the Environmental assessment module itself, such as "Natural risks" and "Environmental impact assessment" (third and fourth courses). Finally, it can contribute in the realization of the "Internships" and the "Undergraduate dissertation".

1.3. Recommendations to take this course

Having studied "Chemical foundations of the environment", "Physical foundations of the environment", "Basic mathematics for environment studies" of the first year and "Meteorology and climatology" of the second year.
On the other hand, students are expected to participate actively in the class throughout the semester.

This subject is offered in the English Friendly Program.

2. Learning goals

2.1. Competences

Basic skills:
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.

Specific skills:
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.
CE6. Capacity to prospectively establish a future evolution scenario to the current diagnosed situation and propose pertinent corrective measures.
CE7. Capacity to elaborate and present reports corresponding to the diagnosis made.
CE9. Mastery of criteria, regulations, procedures and techniques in environmental management and quality systems. This includes the capacity to identify and assess environmental costs; management of water supply and treatment systems; energy optimization with the use of clean and renewable technologies; management of air quality and cleansing of atmospheric emissions; integrated management of health, hygiene and occupational hazard prevention.

Generic skills:
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.
CG5. Capacity of critical reasoning (analysis, synthesis and assessment).
CG6. Capacity to apply theoretical knowledge to an analysis of situations.
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.

2.2. Learning goals

1. To recognize the main **atmospheric polluting activities**.
2. To identify the main **atmospheric pollutants** (natural and anthropogenic).
3. To understand the **behaviour and evolution** of the main atmospheric pollutants in the environment.
4. To explain the **environmental effects** derived from the presence of certain atmospheric pollutants.
5. To explain the role of **stratospheric ozone**:
    the **photochemical cycles** involved in their formation and destruction
    the pollution involved, evolution and consequences of the **ozone hole**
6. To explain the phenomenon of **global warming**: greenhouse gases, radiative forcing, etc.
7. To explain the role of contaminants that cause **acid rain**: its chemical generation and consequences.
8. To explain the problems arising from human activity in areas of high demographic density and to

indicate good environmental practices leading to a reduction in this type of more local pollution

photochemical smog

surface (tropospheric) ozone

substances harmful to health

light and noise pollution

9. To train in the field of **air quality assessment and management**.

10. Identify and describe different methods of **analysis of air pollution**: measurements in immission (confined and open spaces) and in emission.

11. To evaluate the **health risk** conditions according to recommendations, guidelines and specific legislation, established by competent official organizations (national or international).

12. To identify **means to control** air pollution.

13. To handle techniques and current equipment used for the evaluation of the quality of a particular atmosphere through **practical laboratory work**.

14. To **evaluate and predict the dispersion of pollutants** in the atmosphere in different situations of the emitting source and taking into account local meteorology.

15. To handle **specialized software in models of dispersion and diffusion** of pollutants in the atmosphere.

16. To solve **problems and cases** both qualitatively and quantitatively, related to the aspects described above related to air pollution.

17. To **search and manage bibliographic sources**, evaluating the quality and scientific-technical rigor of them.

18. To **work as a group in a coordinated and autonomous manner** on a topic related to a specific aspect of air pollution.

19. To **present in a clear and rigorous** manner the fundamental aspects of the work.

20. 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 - 2 - 3 - 4 - 5 - 7 - 8 - 9 - 11 - 13 - 20	**3**	***3.9***
1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 11 - 12 -13 - 14 - 15 - 16 - 17 - 20	**4**	***4.7***
1 - 2 - 3 - 4 - 6 - 7 - 8 - 11 - 12- 14 - 16 - 20	**9**	***9.4***
1 - 2 - 3 - 4 - 7 - 8 - 9 - 10 - 11 - 12 - 13 - 14 - 15 - 16 - 20	**11**	***11.6***
1 - 2 - 3 - 4 - 6 - 8 - 12 ? 20	**13**	***13.3***

2.3. Importance of learning goals

? They contribute to the knowledge of the basic aspects of air pollution, of the repercussion of the industrial activity of our society on relevant effects such as global warming and the direct relationship between the quality of the air we breathe and its effects on health.

? Provide students with a wide range of information on current techniques to qualitatively and quantitatively assess the quality of a given air and about the current technology available to control and mitigate as much as possible air pollution.

? Enables students to make an assessment of the quality of a given atmosphere.

? The development of thinking skills related to analysis and reasoning is fostered, through the

approach and resolution of issues of a practical nature and applied to real situations.
? Through the development of supervised works and their subsequent presentation to the rest of the class, the aim is to encourage students to:

- the search and selection of relevant bibliography according to its scientific-technical rigor distinguishing between referenced bibliography and that of dubious origin.
- the self-learning of the students, that is to say that they are capable of learning to learn by themselves (self-taught), know where to find bibliography or relevant databases related to air pollution. The promotion of this skill will help them throughout their professional life.
- the knowledge to present in a clear and rigorous way a work done.
- working in a group in a coordinated and effective way with a division of tasks and compliance with the part assumed by each member of the group.

? They familiarize the students with the SDGs, mainly through tutored works and proposed activities (seminars, visits, etc.).

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.

GLOBAL EVALUATION will be carried out according to the EPS exam schedule for the two official calls. The student MUST DO on second call those activities that he has not passed on the first call, and may voluntarily choose to repeat those activities whose grade he wants to improve; In the latter case, the grade that most benefits the student of the two obtained will be awarded.

The activities and evaluation criteria of the global test in both the first and second calls are described below (see also summary table). Although the subject does not carry out continuous assessment, some of these activities can be released during the semester, as explained here.

1. **Theory exams (TE)** (32.5% of the FG)

? Theory exam A: Lessons 1-4 (50% of the TE grade)

? Theory exam B: Lessons 5-7 (50% of the TE grade)

They consist of theoretical questions that may be multiple-choice questions, true-false questions, short answer questions, etc.

Theory exams (TE) will be done on the day scheduled in the official exam calendar (see **NOTE**, below).

2. **Problem exams (PE)** (32.5% of the FG)

? Problems exam A: Lessons 1-4 (50% of the PE grade)

? Problems exam B: Lessons 5-7 (50% of the PE grade)

The problems exams (PE) will be done on the day scheduled in the official exam calendar (see **NOTE**, below).

3. **Academic project (AP)** (20% of the FG)

Realization and oral presentation of a group work (the individual accomplishment in justified cases will be able to be considered) on topics related to the atmospheric pollution agreed with the teaching staff. 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 (60%)

? Oral presentation (30%)

? Deliverables, group work skills, etc. (10%)

The presentation and oral defense of the work will be made on a date prior to the end of the semester set by the teachers, without prejudice to the student's right to take the final global test. 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 (60%). 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 (40%).

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 also, using tools such as self-assessment and hetero-evaluation among students.

4. **Theoretical-practical exam of the laboratory sessions (LE)** (6% of the FG)

Theoretical and practical questions about the corresponding part of the laboratory practice program.

It will take place on the day scheduled in the official exam calendar (see **NOTE**, below).

5. **Theoretical-practical exam of the computer sessions (CS)** (9% of the FG)

Computer development of some exercise of the computer practice program. This exam will not be taken by those students who, having attended at least 2 of the 3 computer sessions, choose to present the reports of each session, on dates prior to the day of the global test, set by the teachers. However, the student who, even having presented those reports, decides to take the exam, may do so (previously communicating it to the teaching staff), and will thus be, renouncing the grade he/she could have obtained in computer practices by delivering reports.

6. **Complementary activities (CA)** (up to 0.5 extra points on the FG)

The activities (visits, seminars, etc.) that can be proposed on a voluntary basis may entail an extra grade on the final grade for the course of up to a maximum of 0.5 points.

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), the latter calculated as the weighted average of the described assessment activities (all of them rated out of 10), according to the indicated percentages. To average with the rest of the activities in the FG calculation, it will be necessary to obtain a score of at least 4 points out of 10, in the different types of compulsory evaluation activities: TE, PE, AP, LE and CS. If this is not met, even if the FG is equal to or greater than 5, the course will not be

considered passed and the grade will reflect the grade of 4.0 (failure). The extra points mentioned will only be added to the FG if it is greater than or equal to 4.5 points out of 10, both in the first and second calls (see summary table).

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

GLOBAL ASSESSMENT (system)*	**Final grade (FG)**	**Observations**
1. Theory exam (TE) multiple-choice questions true-false questions short answer questions	32.5%	Theory exam A (Lessons 1-4): 50% Theory exam B (Lessons 5-7): 50%
1. Problems exam (PE) problem-solving questions	32.5%	Problems exam A (Lessons 1-4): 50% Problems exam B (Lessons 5-7): 50%
3. Academic project (AP) preferably group work	20%	Option to anticipate the global test (recommended): Final job: 60% Oral presentation: 30% Tasks to deliver: 10% Global test option:** Final job: 60% Oral presentation: 40%
4. Lab sessions (LE) lab sessions (exams)	6%	Theoretical-practical examination of laboratory practices
5. Computer sessions (CS) computer sessions (reports)	9%	Option to anticipate the global test (recommended): Reports Global test option: Theoretical-practical exam***
6. Complementary activities (CA)		Voluntary activities that may add up to 0.5 points, to be added to the CF
FG** = 0.325 N_{TE} + 0.325 N_{PE} + 0.2 N_{AP} + 0.06 N_{LE} + 0.09 N_{CS}**		
GG*** = CF + EXTRA POINTS (CA)**		

* Same criteria for first and second call.

** The student must contact the teachers at least one week in advance to specify the subject of the work and the details for the presentation, etc.

*** The student who chooses to take the theoretical-practical computer exam on the day of the global test (instead of submitting the corresponding reports), must express this intention to the teachers one week in advance.

**** A 4 is required as a minimum grade in the five types of evaluation test (TE, PE, AP, LE, CS: all of them are scored over 10 points), to average in the calculation of the FG. If this is not met, even if the FG is equal to or greater than 5, the course will not be considered passed and 4.0 (failure) will be reflected as the grade in the transcript of records.

***** Global grade (GG) will result from the addition to the FG of the possible extra points (up to a maximum of 0.5). These will only be added if FG is equal to or greater than 4.5, both on first and second call. The course is only considered passed if the GG is equal to or greater than 5.

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.

In the case of practices, the accuracy of the results obtained will also be assessed.

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)
3 (3.9)	Theory exams A and B Problems exams A and B Academic project Lab sessions	32,5 32,5 20 6
4 (4.7)	Theory exams A and B Problems exams A and B Academic project Lab sessions Computer sessions	32,5 32,5 20 6 9
9 (9.4)	Theory exams A and B Problems exams A and B Academic project Lab sessions Computer sessions	32,5 32,5 20 6 9
11 (11.6)	Theory exams A and B Problems exams A and B Academic project Lab sessions Computer sessions	32,5 32,5 20 6 9
13 (13.3)	Theory exams A and B Academic project	32,5 20
Additionally, the complementary activities (CA) that may be proposed may involve up to a maximum of 0.5 points 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.

NOTE: The exams A (theory and problems) and the exam of the laboratory practice sessions (LE) are scheduled in the official exam calendar. However, they may be anticipated to a date that the students propose through the class delegate, in agreement with the teaching staff. It should be clear that this is part of the global test that is anticipated and that, in no case, there are two opportunities to pass these

exams. For this reason, it is IMPORTANT that 100% of the students enrolled in the subject agree and must express their consent in writing. If this test is finally anticipated, the new date will be confirmed and communicated to students via Moodle, at least 20 calendar days in advance.

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 and computer sessions, autonomous work and study and assessment tasks.
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 (30 hours). Designed to provide the students with knowledge about the different pollutants of the atmosphere, their chemistry and evolution, as well as techniques of measurement and pollution control. It will be encouraged an interactive environment that will be used to discuss and reinforce the lecture contents.

Problem-solving sessions (12 hours). 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. Working in groups.

Lab sessions (4 hours). This activity requires autonomous study of the protocols and instructions for planned activities before going to the lab. The detection of atmospheric pollutants with different techniques will carried out.

Computer sessions (6 hours). This activity requires autonomous study of the protocols and instructions for planned activities before going to the computer classroom. The use of software to predict the dispersion of pollutants will carried out.

Academic project: This activity requires the student to work preferably in groups on a topic related to atmospheric pollution that extends the contents of lecture and necessarily in previous agreement with the professors, and finally they will elaborate a written report (for example, poster format) and present orally the most relevant of it. 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.

Personalized teacher-student Tutorials.

Autonomous work of the student.

Assessment.

4.3. Syllabus

The course will address the following topics:

Lectures

- **Topic 0**. General issues about the course.
- **Topic 1**. Atmospheric pollution. Natural and anthropogenic pollution. Concepts of emission and immission. Primary and secondary pollutants. Sources and sinks of pollutants.
- **Topic 2**. Pollution phenomena on a global scale. Destruction of the ozone layer. Anthropogenic greenhouse effect.
- **Topic 3**. Pollution phenomena on local and regional scales. Tropospheric ozone. Photochemical smog. Acid rain. Light and noise pollution.
- **Topic 4**. Analytic methods of atmospheric pollution. Air quality.
- **Topic 5**. Pollutants dispersion in the atmosphere. Factors affecting dispersion. Dispersion models. Gaussian dispersion models for gases in the case of instantaneous emissions (puffs). Gaussian dispersion models for gases in the case of continuous sources (plumes).
- **Topic 6**. Britter McQuaid dispersion models for heavier than air gases. Dispersion models for dust.
- **Topic 7. Controlling atmospheric pollution methods**. Particulate material control: Mechanical methods. Filters. Gas scrubbing. Electrofilters. Applications. Gases and vapours control: Direct burning, absorption y adsorption. COVs, NO_x, SO_2. Dust and gases control examples in incineration plants and power plants. CO_2 capture techniques in industrial processes.

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

Lab sessions (LS)

1. Measure of polluting gases: short range colorimetric tubes.
2. Handling of luxometers for the evaluation of illumination levels and handling of gases and particles sensors.

Computer sessions (CS)

1. Gaussian dispersion models for contaminant gaseous atmospheric. Application to instantaneous transmission sources (PUFF).
2. Gaussian dispersion models for contaminant gaseous atmospheric. Application to continued future emissions (PLUME).
3. Britter Mc-Quaid dispersion models for contaminant gaseous atmospheric denser than air.

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

SDG (Target)	Methodology	Learning activity	Program
3 (3.9)	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 Computer sessions Academic visits Group work Tutorials Autonomous work Assessment	Mainly lessons 1-4 y 7 Lab sessions

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 Computer sessions Academic visits Group work Tutorials Autonomous work Assessment	Lessons 1-7 Lab sessions Computer sessions
9 (9.4)	Theory session Learning based in problems Cases of study Oral presentation Laboratory Tutorials Assignments Practice works Complementary activities Assessment	Lectures Practice sessions (problems) Lab sessions Computer sessions Group work Tutorials Autonomous work Assessment	Mainly lessons 1 y 7 Computer sessions
11 (11.6)	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 Computer sessions Academic visits Group work Tutorials Autonomous work Assessment	Mainly lessons 1 y 4 Lab sessions
13 (13.3)	Theory session Learning based in problems Cases of study Oral presentation Tutorials Assignments Practice works Assessment	Lectures Group work Tutorials Autonomous work Assessment	Mainly lessons 1, 2 y 7

4.4. Course planning and calendar

The student must dedicate 150 hours (6 ECTS) including 60 hours 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	4	5	6	7	8	9	10	11	12 (1)	13	14	15	16	17	18	19	20	2
Face-to-face																					
Introduction	1																				
Lectures	1	2	2	2	2	2	2	2	2			4		2	2	2					
Problem seminars	2	1			2		2		2					2		1					
Lab sessions				2		2															
Computer sessions											2	2			2						

Academic Project sessions(2)			1											2						
Academic Project office hours					0,5			0,5					1							
Academic visit(2)									3											
Conference/s (2)									2											
Examination																		4		
Autonomous work																				
Individual work	4	5	5,5	3,5	3	3,5	3	2	3,5	8	4	2	5	4,5	4,5	5,5	8	4,5		
Group work				1	1	1	1		1		1		1							
TOTAL	8	8	8,5	8,5	8,5	8,5	8,5	9	8,5	8	8	8	8	8,5	8,5	8,5	8	8,5	0	0

(1) Wednesday 27th April as Monday

Comp. P3 (G4 y G1: 21st april; G3 y G2: 25th april)

Comp P4 (G3 y G2: 27th april; G4 y G1: 5th may)

(2)Date and time to be confirmed

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 Contaminación ambiental : una visión desde la química / Carmen Orozco Barrenetxea ... [et al.]. Madrid [etc.] : Thomson, D.L. 2002

BB Contaminación atmosférica / Alejandrina Gallego Picó ... [et al.]. Madrid : UNED, 2012

BB Espert Alemany, Vicent. Dispersión de contaminantes en la atmósfera / Vicent Espert Alemany, P. Amparo López Jiménez. Valencia : Universidad Politécnica de Valencia, D.L. 2000

BB Espert, V., López, P. (1998): Complementos de tecnología del medio ambiente. Módulo: Emisión y dispersión de contaminantes. Universidad Politécnica de Valencia

BB Turner, D. Bruce. Workbook of atmospheric dispersion estimates : an introduction to dispersion modelling / D. Bruce Turner. 2nd ed. Boca Raton : Lewis, cop. 1994

BC Aragón, P., Catalá, M. (2013): Problemas de contaminación atmosférica. Valencia: Universidad

Politécnica

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

BC Casal, J. (2007): Evaluation of the effects and consequences of mayor accidents in industrial plants. Elsevier

BC Figueruelo, Juan E.. Química física del ambiente y de los procesos medioambientales / Juan E. Figueruelo, Martín Marino Dávila . Barcelona [etc.] : Reverté, cop. 2004

BC Finlayson-Pitts, Barbara J. Chemistry of the upper and lower atmosphere : theory, experiments and applications / Barbara J. Finlayson-Pitts, James N. Pitts, Jr. San Diego [etc.] : Academic Press, cop. 2000

BC Gutiérrez López, Enrique. Contaminación atmosférica, ruidos y radiaciones / Enrique Gutiérrez López, coordinador ; Francisco Javier Albert Payá. Madrid : Editex, D.L. 2001

BC Manahan, Stanley E. Environmental chemistry / Stanley E. Manahan. 8th ed. Boca Raton [etc] : CRC, cop. 2005**BC**Parker, Albert. Contaminación del aire por la industria / Albert Parker ; [versión española por José Costa López y Rubén Simarro Dorado]. 1ª reimp. Barcelona : Reverté, D.L. 1983 (reimp. 2001)

BC Sierra, Miguel Ángel. Principios de química medioambiental / Miguel Á. Sierra, Mar Gómez Gallego. [reimp. de la ed. de 2007] Madrid: Síntesis, 2008

BC Spiro, Thomas G. Química medioambiental / Thomas G. Spiro, William M. Stigliani ; traducción, Yolanda Madrid Albarrán. 2ª ed. reimp. Madrid [etc.] : Pearson Prentice-Hall, cop. 2004 (reimp. 2009)

For the updated literature please, see here: http://psfunizar10.unizar.es/br13/egAsignaturas.php?id=10977

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.