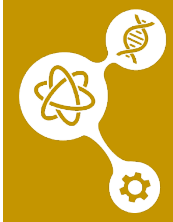
Academic year
2026/2027

Course Guide:

CLIMATE CHANGE



FACULTY OF
CHEMICAL SCIENCES

1. IDENTIFICATION

Degree Programme	Bachelor's Degree in Chemical Engineering			Course Code	801561
Course Name	Climate change			ECTS	6
Subject Area	Sustainability in Chemical Production				
Module	Chemical Technology				
Course Type	Optional	Year	Fourth Year	Semester	Second Semester
Department	Chemical and Materials Engineering				

Teaching Staff

Activity	Lecturer	Email	Office
Lectures/Seminars/Tutorials	FRANCISCO RODRÍGUEZ SOMOLINOS	frsomo@ucm.es	QB-547
Lectures/Seminars/Tutorials	JUAN CARLOS DOMÍNGUEZ TORIBIO	jucdomin@ucm.es	QB-533

2. OBJECTIVES

General objective

The general objective of the subject is to focus on the scientific and technical bases of knowledge about climate change, taking into account the relationship between the production and use of energy and its environmental impact. It begins with a general presentation of the current energy framework, to continue with the analysis of the characteristics of energy production and its environmental interactions, always with special emphasis on climate change. The presentation of the techniques for eliminating atmospheric pollutants continues, knowledge that is poured into certain markedly energy sectors, where emphasis is placed again on their corresponding environmental impacts, which are also subject to study. The aim is for the student to acquire complementary knowledge to their own knowledge that enables them to carry out professional work taking into account the environmental implications derived from the activity carried out in each case, particularly with regard to those related to climate change.

Specific objectives

- Know and understand the global, European and national energy scenario.
- Describe and know conventional and renewable energy sources, as well as the technologies required for this purpose.
- Recognize and weigh atmospheric effluents in different productive sectors.
- Describe and know the technologies used in the purification of discharges into the atmosphere of different origins and compositions.
- Describe and size pollutant control techniques in certain sectors of high energy intensity.
- Know and understand the main environmental impacts on a global scale caused by human activity.
- Know and understand the phenomenon of climate change, its causes and effects, as well as current and developing mitigation and adaptation measures.

3. PRIOR KNOWLEDGE AND RECOMMENDATIONS

Prior knowledge

The proper follow-up of this subject requires that the student has previously acquired the knowledge and skills corresponding to the following subjects: Fundamentals of Chemical Engineering, Fluid Mechanics, Chemical Reaction Engineering, Thermal Engineering and Separation Operations. Although enrolment is not formally conditioned by this prior learning, effective mastery of said knowledge is essential to take this subject with reasonable possibilities of achievement.

Recommendations

It is recommended that the student have a basic level of English that allows them to handle bibliography in English, search for information and communicate in writing and orally in that language. Likewise, it is recommended that you be familiar with computer tools and programs for solving complex problems, as well as applications for writing, editing, and presenting technical reports.

4. CONTENTS

Brief description

Units of measurement of energy and interconversion between them. National and international energy panorama. Energy production. Thermal, nuclear, hydroelectric and renewable. Decontamination of gas effluents. Climate change. Acid deposition, ozone layer destruction and photochemical haze. Corrective measures for climate change and adaptation to it.

Course syllabus

1. Energy sources. Units. Production and consumption of primary energy. Energy resources. Conventional and renewable energy sources. The energy scenario. Current panorama. Tendencies.
2. Energy based on combustion. Energy content of fuels. Conventional thermoelectric plants. Combined cycle power plants. Operating conditions and performance. Clean technologies.
3. Nuclear power. Fusion and fission. Nuclear fuel cycle. Radioactivity. Nuclear waste management. Current situation and prospects.
4. Renewable energy sources. Hydraulic, wind, mini-hydraulic, solar-photovoltaic, solar-thermal, solar-thermoelectric, biomass, geothermal and marine origin (waves, tides and currents).
5. Hydrogen as an energy vector. Methods for obtaining hydrogen. Fuel cells. Electric and hybrid vehicles. Hydrogen economy.
6. The atmosphere. atmospheric regions. Components of air. Atmospheric chemistry. Sources of pollution and pollutants. Meteorology. Contaminant dispersion. Legislation.
7. Pollutant purification techniques. Particle separation. Elimination of volatile organic compounds. Elimination of nitrogen oxides. Removal of sulfur oxides.
8. Emissions control in some sectors. The sequence natural gas-synthesis gas-ammonia-nitric acid. Sulfuric acid. Integrated gasification of fossil resources. Refineries and fuel and vehicle emissions specifications. Manufacture of pulp and paper. The cement industry. Controlled landfills and incineration of R.S.U.
9. Impacts of air pollution. Chemistry of nitrogen and sulfur. Pollution in urban centers: photochemical smog and tropospheric ozone. Pollution associated with nitrogen and sulfur oxides: acid deposition. Destruction of stratospheric ozone. Evaluation of environmental impacts and costs.

10. Climate change. The carbon cycle. Radiative balance of the atmosphere. Causes and effects. The intergovernmental panel on climate change. The Kyoto protocol. Mitigation of climate change and adaptation to its environmental impact. Capture and sequestration (storage) of carbon dioxide. Legislation.

5. COMPETENCES

General competences

CG1-TQ1	Use concepts for the autonomous learning of new methods and theories.
CG1-TQ2	Design and manage applied experimentation procedures, especially for the determination of thermodynamic and transport properties, and for the modeling of phenomena and systems in the field of chemical engineering, systems involving fluid flow, heat transfer, mass-transfer operations, chemical reaction kinetics, and reactors.
CG4-TQ1	Apply concepts of biotechnology, mass transfer, separation operations, and chemical reaction engineering. Evaluate the transformation of raw materials and energy resources.
CG5-TQ1	Analyse, design, simulate and optimise processes and products.

Specific competences

CE16-SPQ1	Recognise and describe the basic concepts relating to the problem of climate change.
CE16-SPQ2	Recognise and analyse atmospheric pollution and its impact on the greenhouse effect, the destruction of stratospheric ozone and acid deposition.
CE16-SPQ3	Recognise and describe climate-change mitigation techniques and techniques for adaptation to its environmental impact.
CE20-SPQ1	Describe the different sources of primary energy and their production and consumption.
CE20-SPQ2	Describe techniques for treating gaseous effluents.

Cross-cutting competences

CT1-TQ1	Develop capacity for analysis and synthesis.
CT2-TQ1	Solve problems in the area of Chemical Technology.
CT4-TQ1	Communicate in Spanish using standard audiovisual media.
CT5-TQ1	Consult, use and analyse bibliographic sources in the area of Chemical Technology.
CT5-TQ2	Consult, use and analyse specialised databases and resources accessible through the Internet.
CT6-TQ1	Use computer tools and programs to calculate, simulate, and approximate.
CT8-TQ1	Demonstrate capacity for critical and self-critical reasoning.
CT11-TQ1	Learn autonomously.
CT12-TQ1	Develop sensitivity to the social and environmental repercussions of engineering solutions.

6. WORKLOAD DISTRIBUTION BY ACTIVITY.

Activity	In-class (hours)	Self-study (hours)	Credits
Lectures	30	70	4
Seminars	15	10	1
Tutorials/guided work	4	6	0,4
Coursework and examination preparation	6	9	0,6
Total	**55**	**95**	**6**

7. METHODOLOGY

The teaching practice will follow a mixed methodology based on cooperative learning, collaborative learning and self-learning. This methodology will be developed through:

Theoretical classes, which will be developed in a single group. They will consist of master classes in which the subject's syllabus will be presented with the help of audiovisual material.

Seminars, which will be held in a single group. They will consist of the formulation and resolution of problems related to theoretical knowledge.

Directed tutorials, which will take place in four groups. They will consist of the direction and supervision of the work done by students in small groups, which will be related to the course contents.

The UCM Virtual Campus will be used to make available to students the material corresponding to the different activities developed during the course, as well as a means of communication between teachers and students.

8. BIBLIOGRAPHY

Basic bibliography

- CAMPBELL; I. M.: "Energy and the atmosphere", Wiley, New York, 1986
- GONZÁLEZ VELASCO, J.: "Renewable energies", Reverté, Barcelona, 2009
- MANAHAN, S. E.: "Introduction to environmental chemistry", Reverté, Barcelona, 2007
- BAIRD, C.: "Environmental chemistry", Reverté, Barcelona, 2001
- HENRY, J. G. and HEINKE, G. W.: "Environmental science and engineering", Prentice Hall, New York, 1996
- NAZAROFF, W. W. and ALVAREZ-COHEN, L.: "Environmental Engineering science", Wiley, New York, 2001.

Complementary bibliography

- ALLEN, D. T. and SHONNARD, D. R.: "Green engineering", Prentice Hall, New York, 2002
- KEATING, E. L.: "Applied combustion", Marcel Dekker, New York, 1993
- HECK, R. M.: "Catalytic air pollution control", Wiley, New York, 2009
- SCHNELLE, K. B. and BROWN, C. A.: "Air pollution control technology handbook", CRC Press, New York, 2002

- MYCOCK, J. C., McKENNA, J. D. and THEODORE, L.: "Handbook of air pollution control engineering and technology", CRC Press, New York, 1995
- RUZER, L. S. and HARLEY, N. H., "Aerosols handbook", CRC Press, New York, 2005
- HARDY, J. T.: "Climate change: causes, effects and solutions", Wiley, New York, 2003
- LLAMAS, B. AND ROMERO, E.: "Technologies to combat pollution", University of Huelva, 2006.

9. EVALUATION

The final grade of the subject will be established, in all calls, taking into account the weighting in the percentages recorded in the evaluations of each of the activities collected below.

❖ WRITTEN EXAMiNATION: 80%

A written exam will be carried out by call that will include the assessment of the theory taught (theoretical classes) and the practical cases presented and solved (seminars), parts that will count respectively at 70 and 30%. As a whole, this assessment will account for 80% of the overall evaluation. It will be necessary to obtain a minimum score of 5.0 points out of 10 in the exam to pass the subject, with the marks of the theoretical part and the practical cases (seminar) being compensated from a 4. The competencies CG1-TQ1, CG1-TQ2, CG4-TQ1, CG5-TQ1, CE16-SPQ1, CE16-SPQ2, CE16-SPQ3, CE20-SPQ1, CE20-SPQ2, CT1-TQ1, CT2-TQ1 and CT8-TQ1.

❖ PERSONAL WORK AND GUIDED ACTIVITIES: 20%

A set of possible works will be proposed to be developed by the students individually or in groups, depending on the number of students enrolled, without this implying ruling out proposals emanating from these students or groups that are related to the subject. The monitoring and evaluation of these works will be carried out in the guided tutorials. The works carried out and their presentations will be evaluated. As a whole, this assessment will account for 20% of the overall evaluation and the two parts (work completed and presentation thereof) will count for 50%. This activity will evaluate the skills CG1-TQ1, CG5-TQ1, CE16-SPQ1, CE16-SPQ2, CE16-SPQ3, CE20-SPQ1, CE20-SPQ2, CT1-TQ1, CT2-TQ1, CT4-TQ1, CT5-TQ2, CT6-TQ1, CT8-TQ1, CT11-TQ1 and CT12-TQ1. It will be essential to obtain a minimum score of 5.0 points out of 10 in the tutorials to pass the subject, with the grades for the work and presentations being compensated from a 4. In the extraordinary call an exam will be carried out focused on the work developed by the different students or groups.

❖ ATTENDANCE AND PARTICIPATION IN CLASSES

Attendance at guided tutorials is mandatory. In theory classes, an attendance rate of 70% is required, otherwise the student will not be able to take the overall evaluation of the subject.

The final grade will result from the weighted average of the evaluable activities. However, to pass the subject it will be necessary to achieve the minimum grade established in each of them. If this requirement is not met, the final grade will be the weighted average obtained, with a maximum of 4.5 out of 10.

The grades of the activities planned for the evaluation of the subject (midterm exams, laboratories, tutorials, delivery of problems...) will be communicated to the students

sufficiently in advance before the final exam, so that they can adequately plan the study of this or other subjects. In particular, the grades for the midterm exams will be communicated within a maximum period of 20 days, except in the case of the second midterm, in which the period may be shorter to adapt to the final exam. In any case, the minimum period of seven days will be respected between the publication of the grades and the date of the final exam of the subject.

ACTIVITY SCHEDULE

UNIT	ACTIVITY	HOURS	GROUPS	START	END
1. Energy sources	Lectures	3	1		
2. Energy based on combustion	Lectures	2	1		
	Seminars	2	1		
3. Nuclear energy	Lectures	2	1		
4. Renewable energy sources	Lectures	3	1		
5. Hydrogen as an energy vector	Lectures	2	1		
	Tutories	1	1		
6. The atmosphere	Lectures	4	1		
	Seminars	3	1		
7. Pollutant purification techniques	Lectures	4	1		
	Seminars	5	1		
	Tutories	1	1		
8. Emissions control in some sectors	Lectures	4	1		
9. Impacts of air pollution	Lectures	2	1		
	Seminars	2	1		
	Tutories	1	1		
10. Climate change	Lectures	4	1		
	Seminars	3	1		
	Tutories	1	1		

SUMMARY OF ACTIVITIES

TEACHING ACTIVITY	ASSOCIATED COMPETENCES	TEACHING ACTIVITY	STUDENT ACTIVITY	EVALUATION	P	NP	TOTAL	C
Lectures	CG1-TQ1, CE16-SPQ1, CE16-SPQ2, CE16-SPQ3, CE20-SPQ1, CE20-SPQ2 CT12-TQ1	Develop sensitivity to the social and environmental repercussions of engineering solutions.	Attention, active participation and assimilation of content during the development of the class.	Written exams.	30	70	100	
Seminars	CG1-TQ2, CG4, TQ1, CG5-TQ1, CT1-TQ1, CT2-TQ1, CT4-TQ1, CT6-TQ1, CT8-TQ1, CT11-TQ1 and CT12-TQ1.	Approach and resolution of numerical issues and problems.	Discussion and resolution of the proposed issues and problems.	Assessment of the resolution and discussion of the proposed issues and problems.	15	10	25	
Tutorials/ Guided coursework	CG1-TQ1, CG5-TQ1, CE16-SPQ1, CE16-SPQ2, CE16-SPQ3, CE20-SPQ1, CE20-SPQ2, CT1-TQ1, CT2-TQ1, CT4-TQ1, CT5-TQ1, CT5-TQ2, CT6-TQ1, CT8-TQ1, CT11-TQ1 and CT12-TQ1.	Tutoring of personal work developed by students.	Development of your personal work.	Assessment of the contribution made by the student in the development of their personal work.	4	6	10	**20%**
Exams	CG1-TQ1, CG1-TQ2, CG4-TQ1, CG5-TQ1, CE16-SPQ1, CE16-SPQ2, CE16-SPQ3, CE20-SPQ1, CE20-SPQ2, CT1-TQ1, CT2-TQ1 and CT8-TQ1.	Design and correction of the exam. Student qualification.	Carrying out the exam.	Theory exam and problem solving.	6	9	15	**80%**

P: In-class activities

NP: Non-classroom activities (self-study)

C: Assessment weighting