VNIVERSITAT DE VALÈNCIA

# Course Guide
# 43806 Transport of pollutants in the environment

## COURSE DATA

| Data Subject | |
|---|---|
| **Code** | 43806 |
| **Name** | Transport of pollutants in the environment |
| **Cycle** | Master's degree |
| **ECTS Credits** | 9.0 |
| **Academic year** | 2022 - 2023 |

**Study (s)**

| Degree | Center | Acad. year | Period |
|---|---|---|---|
| 2227 - M.U. en Ingeniería Ambiental | School of Engineering | 1 | First term |
| 2250 - M.D. in Environmental Engineering | School of Engineering | 1 | First term |
| 3132 - Chemical, Environmental and Process Engineering | Doctoral School | 0 | First term |

**Subject-matter**

| Degree | Subject-matter | Character |
|---|---|---|
| 2227 - M.U. en Ingeniería Ambiental | 1 - Fundamentals of environmental engineering | Obligatory |
| 2250 - M.D. in Environmental Engineering | 11 - Transporte de contaminantes en el medio natural | Obligatory |
| 3132 - Chemical, Environmental and Process Engineering | 1 - Complementos de Formación | Optional |

**Coordination**

| Name | Department |
|---|---|
| SECO TORRECILLAS, AURORA | 245 - Chemical Engineering |

## SUMMARY

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Generally speaking, the study of the transport of pollutants in the natural environment requires, on the one hand, knowledge of the flow of the fluid that constitutes the receiving environment, and on the other, the transport of said pollutant by the movement of the fluid that receives it. For this reason, the general

equations of the turbulent flow of fluids and the transport of pollutants are first studied, and from them particular formulations are derived when they are applied to the different treated media: atmosphere, surface water and groundwater. In addition, these formulations are completed with the expressions that define the kinetics of the physical, chemical and biological processes that constitute sources and sinks of the studied substance, according to the environment in which it has been discharged. Finally, the characteristics and possibilities of different commercial models for the transport of pollutants are discussed; With this, it is intended to record those that are considered most representative in each receiving environment, with the aim of guiding the student in their possible future decisions. Taking into account this scheme, the content of the subject is divided into four modules, which receive the following names:

Module 1. Fluid flow and pollutant transport

Module 2. Transport of pollutants in the atmospheric environment

Module 3. Transport of pollutants in surface waters

Module 4. Transport of pollutants in groundwater

## PREVIOUS KNOWLEDGE

### Relationship to other subjects of the same degree

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

### Other requirements

It is not necessary to take any Master subject simultaneously.
It is necessary to have previous knowledge of: Mathematics (resolution of differential equations, resolution of non-linear equation systems), Basic Fluid Mechanics, Basic Hydraulic.

## OUTCOMES

### 2227 - M.U. en Ingeniería Ambiental

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should communicate conclusions and underlying knowledge clearly and unambiguously to both specialized and non-specialized audiences.

- Students should demonstrate self-directed learning skills for continued academic growth.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Identify and apply technologies, tools and techniques in the field of environmental engineering.
- Assume with responsibility and ethics the Environmental Engineer role in a professional context.
- Adapt to changes, being able to apply the principles of Environmental Engineering to unknown cases and use new and advanced technologies and other relevant developments, with initiative and entrepreneurial spirit.
- Identify, declare and entirely analyze environmental problems.
- Assess the application of measures for the pollution prevention and the recovery, protection and improvement of environmental quality.
- Carry out theoretical analyzes of environmental systems, both natural and artificial, and develop and apply mathematical models for their simulation, optimization or control.
- Apply standard methodologies for the analysis and evaluation of environmental risks.
- Evaluate the environmental quality of water from a global point of view, especially when there is a risk to public health.
- Evaluate the environmental quality of the air from a global point of view, especially when there is a risk to public health.
- Evaluate the environmental quality of soils from a global point of view, especially when there is a risk to public health..

**2250 - M.D. in Environmental Engineering**

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.
- Students should communicate conclusions and underlying knowledge clearly and unambiguously to both specialized and non-specialized audiences.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Identify, formulate and solve complex environmental engineering problems by applying engineering, scientific and mathematical principles.
- Recognise the ethical and professional responsibilities of environmental engineering and make informed judgements considering the impact of engineering solutions in global, economic, environmental and social contexts.

- Conduct appropriate experimentation, analyse and interpret data and use environmental engineering knowledge to draw conclusions.
- Learn and apply new knowledge, using appropriate learning strategies.
- Carry out a comprehensive assessment of environmental air quality.
- Carry out a comprehensive assessment of environmental water quality.
- Implement measures for preventing pollution and recovering, protecting and improving environmental quality.
- Develop and apply mathematical models for the simulation, optimisation or control of processes in the field of environmental engineering.
- Apply tools for environmental assessment and management including environmental impact assessment and environmental risk assessment.

## LEARNING OUTCOMES

1 Reconèixer les fases de la realització i ús dels models de transport de contaminants.

2 Reconéixer els mitjans susceptibles de ser contaminats i les seves característiques hidràuliques.

3 Conéixer els termes de les equacions de el flux de fluids i de l'transport de contaminants abocats al mig fluid i identificar-los en la formulació d'un model computacional.

4 Identificar problemes matemàtics lligats als models de transport de contaminants i les seves possibles solucions.

5 Ser capaços de trobar al mercat models de transport capaços de simular el problema de contaminació que s'estigui estudiant.

6 Ser capaços d'utilitzar models de transport de contaminants aplicats a diferents mitjans receptors.

## DESCRIPTION OF CONTENTS

### 1. Fluid flow and pollutants transport

1. Fundamentals of the mathematical modeling of the pollutant transport
2. Theoretical formulation of the hydrodynamic models
3. Theoretical formulation of transport models
4. Eutrophication models

### 2. Transport of pollutants in the atmosphere

1. The atmosphere as a receptor system for pollutants
2. Analytical solution of the transport equation in atmospheric environment
3. Regional wind model
4. Transport of atmospheric pollutants at regional scale

### 3. Transport of pollutants in surface water

1. Introduction and general concepts
2. General transport equation
3. Water quality models for dissolved oxygen
4. Models of eutrophication

### 4. Transport of pollutants in groundwater

1. Fundamentals of groundwater flow
2. Equation of groundwater flow in saturated porous medium
3. Equation of mass transport in saturated porous medium
4. The MODFLOW, MODPATH and MT3D codes

## WORKLOAD

| ACTIVITY | Hours | % To be attended |
|---|---|---|
| Theory classes | 35,00 | 100 |
| Computer classroom practice | 30,00 | 100 |
| Classroom practices | 20,00 | 100 |
| Theoretical and practical classes | 5,00 | 100 |
| Development of group work | 30,00 | 0 |
| Study and independent work | 40,00 | 0 |
| Preparation of evaluation activities | 30,00 | 0 |
| Preparation of practical classes and problem | 10,00 | 0 |
| Resolution of case studies | 5,00 | 0 |
| **TOTAL** | **205,00** | |

## TEACHING METHODOLOGY

The training activities will be developed according to the following distribution:

• **Theoretical activities.**

Description: In the theoretical classes the topics will be developed providing a global and integrating vision, analyzing in greater detail the key aspects and of greater complexity, promoting, at all times, the participation of the student.

• **Practical activities.**

Description: They complement the theoretical activities in order to apply the basic concepts and expand them with the knowledge and experience that they acquire during the realization of the proposed works. They comprise the following types of face-to-face activities:

• Classes of problems and questions in the classroom

• Discussion and problem solving sessions and exercises previously worked by the students

• Laboratory practices

• Oral presentations

• Programmed tutoring (individualized or in groups)

• **Student's personal work.**

Description: Realization (outside the classroom) of monographic works, directed bibliographic search, issues and problems, as well as the preparation of classes and exams (study). This task will be carried out individually and tries to promote autonomous work.

• **Work in small groups.**

Description: Realization, by small groups of students (2-4) of work, issues, problems outside the classroom. This task complements the individual work and fosters the capacity for integration in work groups.

• **Evaluation.**

Description: Realization of individual evaluation questionnaires in the classroom with the presence of the teacher.The e-learning platform (Virtual Classroom of the Universitat de València and / or PoliformaT of the Polytechnic University of Valencia) will be used as a communication support with the students. Through it you will have access to the didactic material used in class, as well as the problems and exercises to solve.

## EVALUATION

The written tests consist of four independent open-ended tests, one for each module. Each test will take place at the end of the corresponding module, and will last between 45 and 60 minutes. Each test will address the contents that have been seen in the corresponding module. The written tests will be complemented with an academic work for each module, which can be about a topic related to the subject

taught or focus on the resolution of proposed cases in relation to the use of the computer programs worked on in the development of the subject. The final grade for the course will be a weighting of the grades obtained, out of 10, in the tests corresponding to each module. The weighting coefficients will be 0.20 for Fluid flow and transport of pollutants, 0.24 for Transport of pollutants in atmospheric medium, 0.28 for Transport of pollutants in surface waters, and 0.28 for Transport of pollutants in groundwater. Passing the course, the final grade must be equal to or greater than 5.0 points. Students who have not passed the course may take a test recovery exercise written in which they had obtained less than 5.0 points out of 10.

| Name | Description | Quantity | Weight |
|---|---|---|---|
| Open-response written test | Timed test, carried out under control, in which the student constructs his answer. You may or may not be granted the right to consult supporting material. | 4 | 70,00% |
| Academic work | Development of a project that can range from short and simple assignments to broad and complex assignments typical of final courses and doctoral theses. | 4 | 30,00% |

## REFERENCES

### Basic

- Environmental modeling : fate and transport of pollutants in water, air and soil (Schnoor, Jerald L.)
  Surface water-quality modeling (Chapra, Steven C.)
  Modelación de la calidad del agua a escala de cuenca (Andreu Alvarez, Joaquin, Et.Al. )
  Contaminant hydrogeology (Fetter, C.W.)
  Applied groundwater modeling simulation of flow and advective transport(Anderson, Mary P.)
  Applied contaminant transport modeling (Zheng, Chunmiao)