Course guides
250672 - 250672 - Modeling of Environmental Systems

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 758 - EPC - Department of Project and Construction Engineering.
Degree: MASTER'S DEGREE IN ENVIRONMENTAL ENGINEERING (Syllabus 2014). (Compulsory subject).
Academic year: 2020  ECTS Credits: 5.0  Languages: Spanish, English

LECTURER
Coordinating lecturer: JOSE M. BALDASANO RECIO
Others: JOSE M. BALDASANO RECIO

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13340. Apply scientific concepts to environmental problems and their correlation with technological concepts.
13341. Analyze systems, environmental problems and their resolution using models and evaluate them.
13342. Acquire basic skills of laboratory work and identify the methods and instrumentation for the determination of parameters relevant to the analysis of environmental problems.

Transversal:
8562. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
8563. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

TEACHING METHODOLOGY

The course consists of 3 hours a week of classes in a classroom.
The 2 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.
The 1 hour is devoted to solving practical problems with greater interaction with the students. The objective of these practical work and exercises is to consolidate the general and specific learning objectives.
Support material in the form of detailed teaching plan is used by: content, program of learning and assessment activities conducted and literature.

LEARNING OBJECTIVES OF THE SUBJECT

CE01 - Apply scientific concepts to environmental problems and their correlation with technological concepts.
CE02 - Analyze systems, environmental problems and their resolution using models and evaluate them.
CE03 - Acquire basic skills of laboratory work and identify the methods and instrumentation for the determination of parameters relevant to the analysis of environmental problems.

Very aware of the structure of land, water and artificial ecosystems and their interactions.
Meet the ecology and the cycling of elements.
Meet the major environmental problems globally.
Analyzes energy bases, stoichiometric and kinetic of different processes.
Modeling process and quantifies the performance and efficiency of systems.
Determines the basis of environmental hazards to human health and ecosystems.
Apply material balances and energy to environmental problems.
Interprets water-rock and water - air interactions using thermodynamic and kinetic methods.
Meet the pollutants and identify their impact.
Learn the basics of how the atmosphere and applies them in maintaining air quality.
Learn the basics of climate and discusses the implications of current climate change.
Conceptualized an environmental problem described by equations and poses analytical or numerical solution.
Identifies the codes you need to solve a problem as conceptualized.
Recognizes the spatial and temporal scales required to resolve the problem.
Is familiar with solutions to problems relating to dynamical systems.
Learn about simple solutions to problems advection- dispersion - reaction.
Recognizes the existence of uncertainty in the parameters of the equations and is capable of performing an uncertainty analysis and sensitivity.
Learn methods for information and action on various parameters or variables.
Understand that any measure inherently carries an associated error and is able to work with them.
It is critical to the values reported by others when the measurement method is not specified.
He has worked in the laboratory measurement of some parameters of environmental interest.

Introduction to numerical modeling process:
Operation of natural processes.
Defining and understanding the problem.
The process of modeling.
Stages in the development of a numerical model.
The boundaries of a model.
The transport equation.
Spatial and temporal scales: Euler vs Lagrange.
Modelling of dynamic systems:
Modeling of dynamic systems.
Models of water quality in rivers and reservoirs.
Air Quality Models: emissions.
Models of dispersion of pollutants in air.
Photochemical models.
Evaluation Model:
Calibration / verification / validation model.
Evaluation of results.
Uncertainty analysis.

Introduction to numerical modelling process:
Operation of natural processes. Defining and understanding the problem.
The modelling process.
Stages in the development of a numerical model.
The limits of a model.
The transport equation.
Spatial and temporal scales: Euler vs. Lagrange.
Modeling dynamical systems:
Models of water quality in rivers and reservoirs.
Air quality models: emissions.
Models of dispersion of pollutants in air.
Photochemical models.
Evaluation models: calibration / verification / validation of the model.
Evaluation of the results.
Uncertainty analysis.
STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>10.0</td>
<td>8.00</td>
</tr>
<tr>
<td>Self study</td>
<td>80.0</td>
<td>64.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>10.0</td>
<td>8.00</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>10.0</td>
<td>8.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>15.0</td>
<td>12.00</td>
</tr>
</tbody>
</table>

Total learning time: 125 h

CONTENTS

01 Introduction to numerical modeling process

Description:
Introduction to numerical modeling process:
* Operation of natural processes.
* Defining and understanding the problem.
* The modeling process.
Exercises and practical work

Full-or-part-time: 7h 11m
Theory classes: 2h
Practical classes: 1h
Self study: 4h 11m

02 Stages in the development of a numerical model

Description:
Stages in the development of a model
The limits of a model
Exercises and practical work

Full-or-part-time: 4h 48m
Theory classes: 1h
Practical classes: 1h
Self study: 2h 48m
03 The transport equation

**Description:**
- Concept of balance
- Continuity Equation
- Quantity Equation Conservation Movement
- Equation of Conservation of Energy
- Continuity equation of matter
- Exercises and practical work

**Full-or-part-time:** 7h 11m
- Theory classes: 2h
- Practical classes: 1h
- Self study: 4h 11m

04 Spatial and temporal scales: Euler vs. Lagrange

**Description:**
- The spatial scales
- The time cycles
- Eulerian vs Lagrangian Scheme
- Exercises and practical work

**Full-or-part-time:** 4h 48m
- Theory classes: 1h
- Practical classes: 1h
- Self study: 2h 48m

12 Evaluation

**Full-or-part-time:** 16h 48m
- Laboratory classes: 7h
- Self study: 9h 48m

05 Water Quality Models: rivers and reservoirs

**Description:**
- Classification of water quality models (WQM)
- Criteria for the classification of WQM
- historical development
- Dynamics and processes: cycles
- Basic components of the MCA
- Self-purification process
- Simplified temperature model for rivers
- Model QUAL2E
- Reservoir temperature and hydrodynamics
- Water quality model for a reservoir
- Exercises and practical work

**Full-or-part-time:** 7h 11m
- Theory classes: 2h
- Practical classes: 1h
- Self study: 4h 11m
## 06 Air quality models: emissions

**Description:**
Types and models of emission inventory  
Activity factor, emission sources, typology  
Emission Factors  
Emission sources of air pollutants  
Approach top-down vs bottom-up  
SNAP nomenclature groups  
Criteria breakdown  
Criteria of quality analysis inventory  
Speciation  
Exercises and practical work

**Full-or-part-time:** 7h 11m  
Theory classes: 2h  
Practical classes: 1h  
Self study: 4h 11m

## 07 Models of pollutant dispersion

**Description:**
Historical development  
Gaussian model  
Lagrangian model  
Box Model  
Eulerian model  
Exercises and practical work

**Full-or-part-time:** 7h 11m  
Theory classes: 2h  
Practical classes: 1h  
Self study: 4h 11m

## 08 Photochemical models

**Description:**
Ozone Formation  
Formation of secondary aerosols  
Chemical mechanisms  
Exercises and practical work

**Full-or-part-time:** 7h 11m  
Theory classes: 2h  
Practical classes: 1h  
Self study: 4h 11m
## 09 Evaluation of models: calibration, verification, validation

**Description:**
- Evaluation Process
- Calibration / Verification / Validation /
- Hindcast
- Exercises and practical work

**Full-or-part-time:** 4h 48m
- Theory classes: 1h
- Practical classes: 1h
- Self study: 2h 48m

## 10 Performance: metrics

**Description:**
- Variables to evaluate
- Metrics
- Thresholds / Data Quality
- Categorical statistical
- Statistical Discrete
- Diagram Taylor
- Graphics
- Exercises and practical work

**Full-or-part-time:** 7h 11m
- Theory classes: 2h
- Practical classes: 1h
- Self study: 4h 11m

## 11 Analysis of uncertainty

**Description:**
- Evaluation criteria
- Uncertainty Analysis
- Acceptance Criteria
- Sensitivity Analysis
- Model intercomparison

**Full-or-part-time:** 2h 24m
- Theory classes: 1h
- Self study: 1h 24m
GRADING SYSTEM

The course grade will be obtained from continuous assessment scores and corresponding practical work. Continuous assessment consists in several activities, both individually and in group, of additive and formative characteristics, carried out during the course (in the classroom and beyond). The evaluation tests consist of a part with basic issues and questions about concepts associated with the learning objectives of the course with in terms of knowledge or understanding concepts, and a set of exercises for understanding and application. The teaching takes place according to the following criteria:

\[ NF = r*NE + (1-r)*NAC \quad r = 0.5 \]
\[ NAC = q*NAEP + (1-q)*NACET \quad q = 0.5 \]

NF: Final Note
NE: Exam Note
NAC: Note from continuous assessment
NAEP: Note teachings practical assessment (works, presentations, etc.)
NACET: Note continued evaluation of the theoretical teachings (test, etc.)

EXAMINATION RULES.

Failure to perform practical work, laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

BIBLIOGRAPHY

Basic: