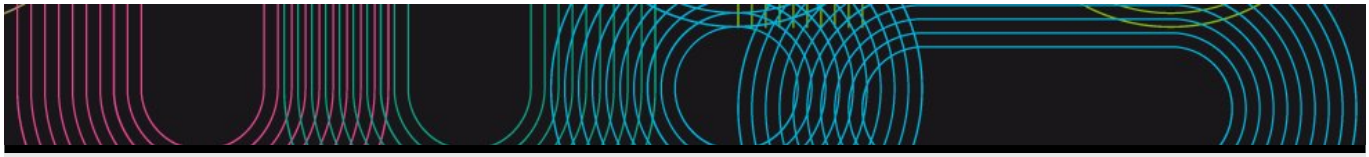

| IDENTIFYING DATA | | | | |
|---|---|---|---|---|
| **Mathematical Models for the Environment** | | | | |
| Subject | Mathematical Models for the Environment | | | |
| Code | V05M135V01205 | | | |
| Study programme | Máster Universitario en Matemática Industrial | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Optional | 1st | 2nd |
| Teaching language | Spanish | | | |
| Department | | | | |
| Coordinator | Busto Ulloa, Saray | | | |
| Lecturers | Busto Ulloa, Saray<br>Rodríguez Seijo, José Manuel | | | |
| E-mail | saray.busto@uvigo.es | | | |
| Web | http://www.m2i.es/docs/modulos/MESimNumerica/MBasica/5.%20Modelos%20matematicos%20en%20medio%20ambiente.pdf | | | |
| General description | This course in focused on the mathematical modelling of environmental processes, including species dynamics and pollution models. | | | |

| Training and Learning Results | |
|---|---|
| Code | |
| B5 | Poseer las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo, y poder emprender con éxito estudios de doctorado |
| C1 | (*)Alcanzar un conocimiento básico en un área de Ingeniería/Ciencias Aplicadas, como punto de partida para un adecuado modelado matemático, tanto en contextos bien establecidos como en entornos nuevos o poco conocidos dentro de contextos más amplios y multidisciplinares. |
| C4 | (*)Ser capaz de seleccionar un conjunto de técnicas numéricas, lenguajes y herramientas informáticas, adecuadas para resolver un modelo matemático. |
| C7 | (*)Saber modelar elementos y sistemas complejos o en campos poco establecidos, que conduzcan a problemas bien planteados/formulados. |

| Expected results from this subject | Training and Learning Results |
|---|---|
| Know the distinct mathematical models for environmental problems. | C1 |
| Achieve formulate any concrete real problems how problems of control. | C7 |
| Apply correctly the methods to resolve several examples. | C4 |
| Making decisions: having to decide the method to use more convenient to resolve the problem like this as the suitable tools, inside the possible ones, for his presentation. | C4 |
| Use of computers: as a tool of indispensable use to realize the numerical calculations correspondents to the models that study in the subject. | C4 |
| Orientation to the attainment: developing and cultivating the enthusiasm when having achieved the full resolution of the entrusted problems. | B5 |

| Contents | |
|---|---|
| Topic | |
| 1. Introduction. | 1.1. Role and stages of mathematical modeling.<br>1.2. Mathematical modeling.<br>1.3. Numerical simulation.<br>1.4. Types of models. |

| | |
|---|---|
| 2. First steps: modeling of biological populations. | 2.1. Models of single species dynamics.<br>2.2. Models of two species dynamics (competition, mutualism, commensalism, predator-prey, migration...)<br>2.3. Age-Structured Models of Population Dynamics. |
| 3. Geophysical flows. | 3.1. Introduction.<br>3.2. Transport-diffusion models.<br>3.3. Shallow water models.<br>3.4. Adsorption and sedimentation.<br>3.5. Dispersive flows models.<br>3.6. Unidimensional models for rivers and channels.<br>3.7. Pollution.<br>3.8. GPR model. |
| 4. Transport and diffusion models. Pollution. | 4.1. Transport and diffusion.<br>4.2. Phenomena involved in the study of pollution.<br>4.3. Some problems of control of the spread of contamination. |
| 5. Models for shallow waters: the Saint-Venant equations. | 5.1. Gravitational flow with free surface.<br>5.2. Shallow water equations.<br>5.3. Erosion and sedimentation. |
| 6. Water pollution. | 6.1. Adsorption and absorption.<br>6.2. Simplified pollution models. |
| 7. Alternative models for shallow waters. | 7.1. Models for dispersive flows.<br>7.2. Multilayer models. |
| 8. Other models with applications in the environment. | 8.1. Models for subsurface waters. Richards equation.<br>8.2. GPR model for continuum mechanics. |

## Planning

| | Class hours | Hours outside the classroom | Total hours |
|---|---|---|---|
| Lecturing | 45 | 90 | 135 |
| Problem solving | 3 | 6 | 9 |
| Problem and/or exercise solving | 1 | 2 | 3 |
| Essay questions exam | 1 | 2 | 3 |

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

## Methodologies

| | Description |
|---|---|
| Lecturing | Presentation of the main theoretical contents of the subject. |
| Problem solving | Solution of problems and brief introduction to further methods extending the content of lectures from a practical point of view. Small exercises will be proposed to the students aiming at applying the knowledge acquired. |

## Personalized assistance

| Methodologies | Description |
|---|---|
| Lecturing | The professor will personally attend the doubts and queries of the students both online (videoconference system and moodle) or onsite (during lessons or tutorials). |
| Problem solving | The professor will personally attend the doubts and queries of the students both online (videoconference system and moodle) or onsite (during lessons or tutorials). |

## Assessment

| | Description | Qualification | Training and Learning Results |
|---|---|---|---|
| Problem and/or exercise solving | Evaluated throught:<br><br>a) Assistance and active participation at lessons.<br><br>b) Development of exercises to be proposed by the professor during lessons. | 50 | C1<br>C4<br>C7 |
| Essay questions exam | Final examination of the subject. | 50 | C1<br>C4<br>C7 |

## Other comments on the Evaluation

## Sources of information

**Basic Bibliography**

C.R. Hadlock, **Mathematical modeling in the environment**, Mathematical Association of America, 1998

N. Hritonenko  Y. Yatsenko, **Mathematical modeling in economics, ecology and the environment**, Kluwer Academic Publishers, 2013

J. Pedlosky, **Geophysical fluid dynamics**, Springer Verlag, 1987

**Complementary Bibliography**

S.C. Chapra, **Surface water-quality modelling**, WCB/McGraw Hill, 1997

P.L. Lions, **Mathematical topics in fluid mechanics. Vol. 2: Compressible models**, Clarendon Press, 2013

G.I. Marchuk, **Mathematical models in environmental problems**, North-Holland, 1986

J.C. Nihoul, **Modelling of marine systems**, Elsevier, 1975

L. Tartar, **An introduction to Navier-Stokes equation and oceanography**, Springer Verlag, 2006

R.K. Zeytounian, **Meteorological fluid dynamics**, Springer Verlag, 1991

## Recommendations

**Subjects that continue the syllabus**

Professional Software in Environment/V05M135V01216

**Subjects that are recommended to be taken simultaneously**

Advances in Finite Volumes/V05M135V01219

**Subjects that it is recommended to have taken before**

Partial Differential Equations/V05M135V01103
Mechanics of Continuous Media/V05M135V01105
Optimisation and Control/V05M135V01106

**Other comments**

It is recommended:
1. Assistance and active participation at lessons.
2. Weekly study.