UAB Universitat Autònoma de Barcelona	Research and Innovation Code: 43475 Credits: 6	2026/2027

Degree programme	Type	Course
Modelling for Science and Engineering	OB	1

Contact lecturer

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Teaching staff

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Group languages

You can consult this information at the end of the document.

Prerequisites

There are no specific prerequisites. Students must have mathematical skills at a graduate level of a scientific or technological degree.

Objectives

The aim of this module is to show students the variety of fields in which they will be able to apply the tools acquired during the Master courses. Hopefully they will be able to use them as guidance when looking for Internships in Companies and Institutions and also when choosing a topic and an advisor for the Master's Thesis. We also expect that it will help them to find a career path.

Learning outcomes

- CA06 (Properly integrate modelling tools and/or results from different fields or of different types, especially in the context of multidisciplinary work environments.) Properly integrate modelling tools and/or results from different fields or of different types, especially in the context of multidisciplinary work environments.
- CA07 (Critically assess the need for and presence of ethical, sustainability, gender equality and/or social justice criteria in studies or modelling projects.) Critically assess the need for and presence of ethical, sustainability, gender equality and/or social justice criteria in studies or modelling projects.
- CA08 (Work in multidisciplinary teams on the development of activities and projects in the field of Modelling.) Work in multidisciplinary teams on the development of activities and projects in the field of

Modelling.
- KA06 (Identify the programming languages and environments, as well as the most relevant mathematical tools, that are used in the industrial and research field.) Identify the programming languages and environments, as well as the most relevant mathematical tools, that are used in the industrial and research field.
- KA07 (Identify the main sectors and professional contexts in which mathematical modelling is applied.) Identify the main sectors and professional contexts in which mathematical modelling is applied.
- KA08 (Describe the main results and/or predictions of the different mathematical tools used in the professional sector to construct models.) Describe the main results and/or predictions of the different mathematical tools used in the professional sector to construct models.
- SA07 (Correctly contextualise computer applications aimed at modelling an industrial or specific process, using an appropriate programming environment.) Correctly contextualise computer applications aimed at modelling an industrial or specific process, using an appropriate programming environment.
- SA08 (Properly interpret the results and predictions obtained from applying a mathematical model to solve specific problems in the industrial or research field.) Properly interpret the results and predictions obtained from applying a mathematical model to solve specific problems in the industrial or research field.

Contents

During the semester, there will be two types of activities: three short courses and a series of seminars delivered by professionals working in industry as well as researchers from universities and research centers.

The courses are as follows:

Cloud-Based Modeling. Catastrophic risks and early warning systems. How to model natural hazards. From a mathematical model to a cloud-based service.

Python for Data Analytics. Basic concepts of Python. Data handling with Python. Problem solving using Python. Machine learning with Python.

Machine Learning. Machine learning, artificial intelligence, and data science: from deterministic to stochastic approaches. Supervised and unsupervised learning techniques: from decision trees to random forests. Introduction to neural networks and their mathematical challenges: performance evaluation. ROC curves and cross-validation.

For the seminar series, we will invite experts in the fields of Complex Systems Modeling, Engineering Modeling, Mathematical Modeling, and Data Science.

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Attending Mini-courses	22	0.88	CA06, CA08, KA06, KA07, KA08, SA07, SA08
Attending Lectures	16	0.64	CA06, CA07, CA08, KA07, SA08

The methodology of the three courses is based on lectures consisting of the presentation of theoretical concepts, illustrative examples, and selected practical case studies.

Regarding the seminars, they will be announced in advance on the virtual campus of the *Research and*

Innovation module. Students will find the seminar title, the speaker's name, a brief abstract, and relevant links for further information.

Annotation: within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Report on Python for analitical purposes	30%	32	1.28	CA06, CA08, KA06, KA08, SA07, SA08
Making a report on Maching Learning	30%	32	1.28	CA06, CA08, KA06, KA08, SA07, SA08
Making a report on Natural Hazards	30%	32	1.28	CA06, CA08, KA06, KA07, KA08, SA07, SA08
Attending Lectures	10%	16	0.64	CA06, CA07, KA07, KA08, SA08

Students must present three projects corresponding to the three courses taught.

Each of these projects accounts for 30% of the grade.

On the other hand, attendance to the talks, which is mandatory, contributes 10% of the final grade.

Bibliography

- Bibliography and links of interest

- https://www.python.org/about/gettingstarted/
- https://www.learnpython.org/
- https://learntocodewith.me/posts/python-for-data-science
- Pitts W McCulloch W. A logical calculus of the ideas immanent in nervous activity. Bulletin of Mathematical Biophysics, 5, 1943.
- L. Breiman, J.H. Friedman, R.A. Olshen and C.J Stone. Classification and Regression Trees. Wadsworth, Belmont, Ca, 1988.
- Friedman, Jerome H. Data Mining and Statistics: What's the connection?\". Computing Science and Statistics. 29. 1998.
- B Ripley. Pattern Recognition and Neural Networks, Cambridge University Press, Cambridge. 2002.
- T Hastie, R Tibshirani, J Friedman. The Elements of Statistical Learning. Data Mining, Inference and Prediction, Springer, New York. 2009.
- Bishop, C. M. Pattern Recognition and Machine Learning, Springer, ISBN 978-0-387-31073-2. 2006.
- Ethem Alpaydin. Introduction to Machine Learning (Fourth ed.). MIT. 2020.

Software

The software will be detailed in each one of the courses.

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this link. To access the information, you will need to enter the course CODE

Type of teaching	Group	Language	Semester	Shift
(TEm) Theory (master)	1	English	first semester	afternoon