

Applied Modelling & Simulation

Code: 43480
ECTS Credits: 6

Degree	Type	Year	Semester
4313136 Modelling for Science and Engineering	OT	0	2

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: english (eng)

Teachers

Ana Cortés Fité
Remo Suppi Boldrito
Gemma Sanjuan Gomez

Prerequisites

User knowledge of computer systems and (recommended) some knowledge of a programming language but not essential.

Objectives and Contextualisation

The present course aims to:

- Introduce students to the modelling and simulation techniques used in multidisciplinary areas.
- Apply the appropriate methodology for developing models in multidisciplinary areas.
- Evaluate modelling and simulation tools available for different areas.
- Model and simulate structures of different types.

Competences

- Analyse complex systems in different fields and determine the basic structures and parameters of their workings.
- Analyse, synthesise, organise and plan projects in the field of study.
- Formulate, analyse and validate mathematical models of practical problems in different fields.
- Present study results in English.
- Safeguard, manage, audit and certify the quality of advanced developments, processes, systems and software.
- Solve complex problems by applying the knowledge acquired to areas that are different to the original ones.
- Use appropriate numerical methods to solve specific problems.

Learning Outcomes

1. Analyse, synthesise, organise and plan projects in the field of study.
2. Describe the different components of a system and the interactions between them.
3. Identify the parameters that determine how a system works.
4. Implement appropriate numerical methods to solve models in the field of engineering.
5. Model engineering systems using commercial tools.
6. Present study results in English.
7. Simulate the behaviour of complex systems.
8. Solve complex problems by applying the knowledge acquired to areas that are different to the original ones.
9. Validate the simulation results with the predictions of the models and the behaviour of the real system.

Content

Module 1: Agent Based Models (ABM) & simulation.

- Definition of ABM. Abstractions. Models & Simulation.
- Netlogo Framework.
- Case studies: Social & Health Sciences models.

Module 2: Modelling in engineering

- Tools for structural modelling
- Structures design
- Structural Simulation

Module 3: Applications of Complex Physical Models

- Forest fire spread models: basic and Rothermel model, global models
- Input uncertainty: Data Driven Systems (Genetic Algorithms, Statistic Systems)
- Multi-model prediction system (Numerical Weather Prediction, Wind Field model, Fuels models..)
- Numerical weather forecast models: Numerical Weather Prediction (NWP)
- Basic concepts of Atmospheric Modelization. NWP models and computational power
- Applications of Numerical Weather Prediction at the Meteorological Service of Catalonia (SMC).
- Climate models, Earth System prediction: the EC-Earth model (Integrated Forecasting System (IFS), Ocean Model (NEMO), ..)

Methodology

The course will be developed in theoretical classes, practical exercises and seminars with guest speakers.

It is recommended that students attend all classes of the subject with a laptop with a well-charged battery.

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.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Theoretical Lectures	12	0.48	2, 3, 5, 8
Type: Supervised			

Practical sessions	26	1.04	1, 4, 7, 9
Type: Autonomous			
Collaborative work	40	1.6	1, 4, 7, 9
Individual (personal work)	20	0.8	1, 2, 4, 5, 7, 9
Technical documentation study and preparation	45	1.8	6, 2, 3, 5

Assessment

The evaluation will be made by developing and presenting the proposed case studies using the tools presented in the lecture sessions. Group work and interaction will also be assessed.

In the case that the student has an evaluation of less than 5 points in some sections of the assessment (except the Lab), the student will have to do an additional (in person) test on the particular section.

Academic Integrity

If the student use someone else's work (code, figures, research publications, etc.) to produce any work for this course, the student must:

1. indicate how this work was used,
2. acknowledge this work in a bibliography section.

Violation of these policies will be considered a breach of academic integrity, and the student will be subject to penalties outlined by the MsC studies coordination at the Faculty of Sciences. The student is subject to the rights and responsibilities that includes an academic (grade) penalty administered by the professor and/or disciplinary action through the UAB judicial process by plagiarism responsibilities.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Agent Based Models (ABM) and Simulation	20%	1	0.04	4, 7, 9
Environmental modelling and simulation: Case study	50%	4	0.16	4, 8, 7, 9
Structural simulation	30%	2	0.08	1, 6, 2, 3, 5, 8

Bibliography

- M. P. Groover. Fundamentals of Modern Manufacturing, Materials, Processes, and Systems. Prentice Hall. 1996.
- Karl T. Ulrich and Steven D. Eppinger. Product Design and Development. Third Edition, McGraw-Hill, 2004
- Bernard P. Zeigler. Theory of Modeling and Simulation. Academic Press. 2000
- Sheldon Ros. Simulation. Academic Press. 2012.
- Angela B. Shiflet, George W. Shiflet (Author). Introduction to Computational Science: Modeling and Simulation for the Sciences. Princeton University Press. 2014.
- Byoung Kyu Choi, DongHun Kang. Modeling and Simulation of Discrete Event Systems. Wiley. 2013.
- Nigel Gilbert and Klaus Troitzsch. Simulation for the Social Scientist. Open University Press. 2005.
- Hazeleger W. et al, EC-Earth: A seamless Earth-system prediction approach in action. American Meteorological Society, vol 91, 10, 1357-1368, 2010, doi: 10.1175/2010BAMS2877.1

- Andrés Cencerrado, Ana Cortés, Tomàs Margalef, "Response time assessment in forest fire spread simulation: An integrated methodology for efficient exploitation of available prediction time". Environmental Modelling and Software 54. 2014.
- Kerstin Wendt, Ana Cortés, Tomàs Margalef, "Parameter calibration framework for environmental emergency models", 10-21. Simulation Modelling Practice and Theory ,31. 2013.

ABM (UAB CATàleg):

- [\(BR\) Introduction to Discrete Event Simulation and Agent-based Modeling](#). Theodore T. Allen; Doyle.
- [\(BR\) Agent-Based Spatial Simulation with NetLogo, Volume 2: Advanced Concepts](#). Arnaud Banos; Christophe Lang; Nicolas Marilleau. Elsevier.
- [\(BR\) Agent-Based Spatial Simulation with NetLogo Volume 1](#). Arnaud Banos; Christophe Lang; Nicolas Marilleau. Elsevier.
- Agent-Based Modelling in Economics. Lynne Hamill; Nigel Gilbert. John Wiley & Sons Incorporated.
- Agent-based Computational Modelling: Applications in Demography, Social, Economic and Environmental Sciences Francesco C. Billari; Billari; Alexia Prskawetz; Jürgen Scheffran; Thomas Fent. Physica-Verlag Heidelberg.
- Innovative Approaches in Agent-Based Modelling and Business Intelligence. Setsuya Kurahashi; Hiroshi Takahashi; Hirachi.

Websites:

- Netlogo: <https://ccl.northwestern.edu/netlogo/>

Software

SolidEdge

WRF-Chem

FARSITE

WindNinja

VirtualBox, Netlogo.