Use of languages
Principal working language: english (eng)

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Teachers
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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 simulation structures of different types.

Skills
- 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: Introduction to applied models & simulation.

• Definition of systems. Abstractions. Models, Model Data & Simulators.
• From abstraction to practice: A basic queue simulator using SMPL.
• Discrete Event Simulation. Petri Networks.
• Agent Based Simulation (ABM). Netlogo Framework.
• High Performance Simulation: how reduce the simulation time of ABM.

Module 2: Modelling and Simulation applied to engineering.

• Introduction to design process in engineering.
• From concept to manufacture: Frameworks and Tools.
  Numerical Simulation in Engineering (FEA)
  Virtual Prototyping - Concepts and Practise.
  Industrial Process Modelling and Simulation
  Cost Modelling and Simulation
• Design Optimization Introduction

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 classes, lab sessions and seminars with guest speakers.

Activities

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<th>Title</th>
<th>Hours</th>
<th>ECTS</th>
<th>Learning outcomes</th>
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<td>2, 3, 5, 8</td>
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Evaluation

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

Evaluation activities

<table>
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<th>Weighting</th>
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<td>4</td>
<td>0.16</td>
<td>1, 2, 3, 4, 5, 6, 7, 8, 9</td>
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Bibliography

- 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.

Websites:

- Netlogo: https://ccl.northwestern.edu/netlogo/
- Petri .NET Simulator: Tool for modelling and simulation of Petri nets and analysis of their behaviour http://www.petrinsimulator.com/
- SMPL Simulation Toolkit: http://ece.ut.ac.ir/Classpages/S86/ECE462/#Software
- SMPL Examples, Source & complementary material: http://www.csee.usf.edu/~christen/tools/toolpage.html