Applied Modelling & Simulation 2015/2016

Code: 43480
ECTS Credits: 6

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

Contact

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Use of languages

Principal working language: english (eng)

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. Netlogo Framework.

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 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): A general overview
  - Basic concepts of Atmospheric Modelization: Approximations and Parameterizations
- NWP models and computational power
- Applications of Numerical Weather Prediction at the Meteorological Service of Catalonia (SMC).
  - The Meteorological Service of Catalonia (SMC). NWP models used by the SMC
  - Some post-processing examples at the SMC: NWP model outputs, downscaling models, MOS (model output statistic), temperature interpolation, practical data processing with python
- 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

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Lectures	26	1.04	2, 3, 5, 8

Type: Supervised			
Lab	12	0.48	1, 4, 7, 9
Type: Autonomous			
Collaborative work	20	0.8	1, 4, 7, 9
Individual (personal work)	40	1.6	1, 2, 4, 5, 7, 9
Preparation and study	48	1.92	2, 3, 5, 6

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

Title	Weighting	Hours	ECTS	Learning outcomes
Cases Studies: Analysis & Development	100	4	0.16	1, 2, 4, 5, 6, 7, 8, 9

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 alter, 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.

Websites:

- Netlogo: https://ccl.northwestern.edu/netlogo/
- Jarp: Petrinets Analizer, http://jarp.sourceforge.net/us/index.html
- Jpetrinet: Tool to model, analysis conventional Petri Nets and to simulate Timed Petri Nets, http://jpetrinet.sourceforge.net/
- Petri .NET Simulator: Tool for modelling and simulation of Petri nets and analysis of their behaviour http://www.petrinetsimulator.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
- SMPL API description: http://people.cs.vt.edu/~irchen/5214/pdf/p1-23.pdf