

PhD-Course: Advanced Computer Aided Modelling

Lecture Schedule and course outline

Course objectives: To train the participants on the use of advanced (systematic) modelling methods and tools for various modelling objectives.

Course description: The course provides coverage of introductory and advanced process modelling and solution concepts for different types of models (lumped and distributed systems), different modes of models (steady state and dynamic) and different forms of model (simple-complex, large-reduced, discrete-continuous). Starting with definition of the modelling objectives, to the derivation of the model equations representing the system, to the analysis of the model equations, to developing different solution strategies for different modelling objectives to final application of the developed model will be covered in the course. It will be illustrated why using a systematic modelling approach has advantages, what methods and tools need to be used and how they can be applied. The course should help the participant to develop skills in model formulation, analysis and solution of the model equations.

Course background: The course is based on the books “Process modelling and model analysis” by Katalin Hangos and Ian Cameron; and “Process and product modelling – A case study approach” by Ian Cameron and Rafiqul Gani. These books describe the use of models in process engineering. Process engineering is all about manufacturing of just about anything! To manage processing and manufacturing systematically, the engineer has to bring together many different techniques and analyses of the interaction between various aspects of the process. For example, process engineers would apply models to perform feasibility analyses of novel process designs, assess environmental impact, and detect potential hazards or accidents. To manage complex systems and enable process design, the behaviour of systems is reduced to simple mathematical forms. The course will therefore provide a systematic approach to the mathematical development of process models and highlight how to analyze and solve those models.

Course organization: This is a 1-week intensive course where there will be lectures and hands-on exercises. The ICAS-ModFrame (modelling framework) will be used in the tutorials. Participants may, however, use any other tools such as, Matlab.

Who should attend: The course designed for mainly PhD-students. However, MSc-level students and anybody else who would like to learn about computer-aided modelling tools and how to use them are also welcome to attend.

Course outline and schedule

Date	Lecture	Topic	Tutorial/exercise
Day-1		Modelling basics	
	1	Introduction to modelling	Exercise
	2	Model building framework	
	2a	Conservation principles	
	2b	Constitutive Models	
		Introduction to MoT	
Day-2		Model types and model generation	
	3	Modelling lumped parameter systems	Tutorial with ICAS-ModDev
	4b	Modelling distributed parameter systems	
	4c	Multiscale modelling	
	4a	Computer-aided model generation (lecture 4 tutorial documents)	
Day-3		Model analysis & solution strategies	
	5a	Model analysis: lumped parameter and distributed parameter systems (lecture 5 notes – index problem)	Tutorial with ICAS-MoT
	5b	Analysis of process models	
	6a	Solution strategies for lumped parameter systems	
	6b	Solution strategies for distributed parameter systems	
Day-4		Model identification (parameter estimation)	
Morning	7	Model identification, calibration and validation (sample MoT-files)	Exercise
Afternoon	8	Model discrimination (lecture 8 model discrimination tutorial document)	Exercise
Day-5		Modelling template & modelling case studies	
Morning	9	Template-based modelling (lecture plus tutorial)	Exercise
Afternoon	10	Modelling case studies: Evaporation from a droplet; short-path evaporation (lecture 9 case studies document) Modelling for control & diagnostics; Modelling of discrete event systems; modelling of hybrid systems (self-study)	

Course Book

K. Hangos & I. Cameron “Process modelling and model analysis”, Academic Press 2001

I. Cameron & R. Gani “Process product modelling – A case study approach ”, Elsevier, 2011

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Lecture notes plus ICAS-ModFrame (modelling software) based tutorials.

Course Lecturer

Professor Dr. Rafiqul Gani

PSE for SPEED

Bangkok, Thailand/ Allerød, Denmark