MSE | MASTER OF SCIENCE IN ENGINEERING

Special Course (SpC) on MSE Moodle Platform

Title: *Dynamic models for direct and inverse problems in thermal transfer*

Abbrev: EVA_DMT

Credits	3
Responsible UAS	ZHAW
Responsible MRU	IEFE
Course responsible	till@zhaw.ch, Christian Ghiaus: christian.ghiaus@insa-lyon.fr
Examination	Oral (project defence for groups of 4-6 students). Written (individual 2h exam)
Start date	30/10/2017, 03/11/2017, 04/11/2017 each 8 hours
End date	
Location	Winterthur
Course type	Lectures: 4 modules (each module min 2h, optimum 4h, extended 6h); last module is optional Tutorials: 6 modules (each module min 2h, optimum 4h, extended 6h), last 2 tutorials are optional Project
Language	English
Short Content (max. 300 chars)	The course presents practical modelling the heat transfer with applications to building design, simulation, optimization, and control.
Content and Goals	Lectures Module 1 (min 2h – optimum 4h – extended 6h) thermal transfer phenomena: conduction, convection and radiation Module 2 (min 2h – optimum 4h – extended 6h) continuous and discrete models: thermal networks; transforming the thermal networks into state-space representation and transfer functions coupling the models Module 3 (min 2h – optimum 4h – extended 6h) Basic psychrometric processes and the modeling of HVAC systems Design and simulation of HVAC systems coupled to

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	buildings (in French) Optional: Module 4 (min 1h –optimum 2h – extended 4h) simulation: examples and discussion using models for parameter optimization using models for control design Contents on the tutorials, labs and group works: Tutorial 1 (min 2h – optimal 4h): Read weather data and calculate solar radiation 1) introduction to linear algebra and tools (MATLAB, Octave, Scilab); 2) use OCTAVE for reading (weather) data 3) calculating the solar load Tutorial 2 (min 2h – optimal 4h): Simple wall 1) Physical analysis and mathematical models 2) Discretization of mathematical models 3) Numerical stability 4) Implementation 5) Discussion Tutorial 3 (min 2h – optimal 4h): simple building in free-running 1) Physical analysis and mathematical models 2) Discussion of examples 3) Implementation Tutorial 4 (min 2h – optimal 4h): simple building with HVAC system 1) Physical analysis and mathematical models 2) Discussion of examples 3) Implementation Tutorial 5 (min 2h – optimal 4h) HVAC for winter conditions Tutorial 6 (min 2h – optimal 4h) HVAC for summer conditions Project (min 6h – optimal 12h) The students will define their own subject for energy analysis of buildings. Examples of projects:

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	- influence of insulation, orientation, ration of window surface - design a Passivhaus and check energy performance - study of cooling by natural ventilation - comparison of floor-heating with fan-coils heating - influence of set-point setback - influence of inertia in intermittently heated buildings - optimization of building parameters
Pre-requisites	Required: linear algebra, calculus, heat transfer, computer programming (undergraduate level) Desirable (but not compulsory): dynamic systems, control engineering
Literature	The course is self-contained: no additional materials are necessary (teaching materials and slides for lectures and tutorials will be provided as PDF). Desired (but not compulsory) bibliography: - G. Strang (2007) Computational Science and Engineering, Wellesley-Cambridge Press, ISBN-10 0-9614088-1-2 - C. Ghiaus (2013) Causality issue in the heat balance method for calculating the design heating and cooling load, Energy, vol. 50, pp. 292-301 - C. Ghiaus (2014) Linear algebra solution to psychometric analysis of air-conditioning systems, Energy vol. 74, pp. 555-566
Special requirements	No special requirement. OCTAVE software is free and open-source; it can be installed on Windows, macOS and Linux operating systems.