MSE | MASTER OF SCIENCE IN ENGINEERING

Zürcher Hochschule für Angewandte Wissenschaften

zhaw School of Engineering

Supplementary Course (EVA) at ZHAW School of Engineering

Title: Computational science and engineering for intelligent energy buildings

Short Code: rEVA_CE4IB

ECTS Credits	3
Profile	Mechanical Engineering (ME)
Responsible Institute /Centre	Institute of Energy Systems and Fluid Engineering (IEFE)
Responsible lecturer and contact informtion	Frank Tillenkamp: till@zhaw.ch, Christian Ghiaus: christian.ghiaus@insa-lyon.fr
Type and duration of examinations	33.3% Written exam 1h, w/o documents on 06/12/2024 33.3% Written report of group project due on 04/12/2024 33.3% Oral presentation of group project on 06/12/2024
Start date and duration	Semester: Autumn Detail: 28/10/2024 09:00 – 01/11/2024 18:00 End date (exam) 06/12/2024 09:00 – 12:00
Location	Winterthur
Course type	BLOCK-COURSE Face to face lectures and tutorials 8h/day 20 h (22 %) First 2 ½ days: Face to face accompanied project 8h/day 20 h (22 %) Next 2 ½ days: Autonomous group project 50 h (56 %) 04/11/2024 – 04/12/2024 Total 90 h (100 %)
Language of instruction	English
Short description (max. 300 characters)	Buildings are responsible for about 40 % of the energy consumption and CO_2 emissions. The course develops computational skills in Python for modelling and problem solving of coupled heat transfer with special applications to optimize energy consumption for indoor climate control.
Contents and Learning Objectives	**Face to face** Lecture module 1 • Thermal transfer: conduction, convection, and radiation. Lecture module 2 • Continuous and discrete models. • Thermal networks. • Transforming the thermal networks into state-space and transfer functions.

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	• Coupling the models. Tutorial 1: Read weather data and calculate solar radiation 1) Introduction to linear algebra and tools (Python, Numpy, Matplotlib). 2) Use Python for reading (weather) data. 3) Calculate the solar load. Tutorial 2: Simple wall 1) Physical analysis and mathematical models. 2) Discretization of mathematical models. 3) Numerical stability. 4) Implementation. Tutorial 3: Simple building in free-running: controlled natural ventilation 1) Physical analysis and mathematical models. 2) Discussion of examples 3) Implementation. Tutorial 4: Simple building controlled by an HVAC system 1) Physical analysis and mathematical models. 2) Discussion of examples. 3) Implementation. **Accompanied individual mini-project:** Intelligent control of a single zone building **Autonomous group project:** Students define their own subject on indoor climate control; for example: - dynamic insulation, - dynamic solar protection, - control of floor-heating and fan coils, - influence of set-point setback, - control of intermittently heated buildings, - model predictive control.
Prerequisites	Required (undergraduate level): linear algebra, calculus, thermodynamics, heat transfer, computer programming. Desirable (but not compulsory): dynamic systems, control engineering, programming in Python.
Literature	The course is self-contained: all teaching materials are provided as PDF (bibliography, supporting materials, slides for lectures, and tutorials in Python). Bibliography • G. Strang (2007) Computational Science and Engineering, Wellesley-Cambridge Press, ISBN-10 0-9614088-1-2

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	• J.A. Clarke (2001) Energy Simulation in Building Design, 2nd edition, Butterworth Heinemann, ISBN 0 7506 5082 6 • C. Ghiaus (2013) Causality issue in the heat balance method for calculating the design heating and cooling load, Energy, vol. 50, pp. 292-301 • Ghiaus, C., & Ahmad, N. (2020). Thermal circuits assembling and state-space extraction for modelling heat transfer in buildings. *Energy*, *195*, 117019 • The Python Tutorial https://docs.python.org/3/tutorial/ • Ghiaus, C. (2022). Dynamic models for building energy management, https://github.com/cghiaus/dm4bem			
Special requirements	Every student needs to have a laptop during the course. Before the beginning of the course, students need to have Python (Anaconda distribution is recommended) on their laptops.			
Offer for profiles	Aviation (Avi)	☐	Business Engineering (BE)	☐
	Computer Science (CS)	☐	Data Science (DS)	☐
	Electrical Engineering (ElE)	☒	Energy & Environment (EnEn)	☒
	Mechanical Engineering (ME)	☒	Mechatronics & Automation (MA	☒
	Medical Engineering (Med)	☐	Photonics and Laser Engineering (Pho)	☐
	Information and Cyber Security (ICS)	☐	Civil Engineering (CE)	☐