SUMMER SCHOOL 2017

3 – 7 JULY 2017, Granada, Spain

Dynamic Methods for whole Building Energy Assessment

UNIVERSIDAD DE GRANADA

etsa

Deadline for submission is 1st June 2017

Organised by: DYNASTEE-INIVE and the School of Architecture (University of Granada, Spain) in collaboration with CIEMAT (Spain), DTU (Lyngby, Denmark) and ESRU (Strathclyde University, Glasgow).

Lecturers: Hans Bloem (JRC, Ispra), María José Jiménez (CIEMAT), Henrik Madsen (DTU, Lyngby, Denmark), Paul Strachan (Strathclyde University, Glasgow, UK) and Paul Baker (Glasgow Caledonian University, UK)

The Centre for IT-Intelligent Energy Systems, CITIES, is a Danish strategic research centre with a range of world wide industrial and academic partners. CITIES aims at accomplishing energy integration through the use of IT solutions for design and operation of integrated energy systems in future smart buildings and cities; see also www.smart-cities-centre.org

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DYNASTEE INIVE

Introduction

After 5 very successful editions of the Summer School on *"Dynamic methods for whole building energy assessment"* the organisers have decided to focus more on pragmatic application of these dynamic calculation techniques meaning that the analysis of building metering data is of high importance and can give potentially high value information to utility and end-user. The focus will be this time on the use of the software tool LORD and applied to benchmark data. Also routines for the R-environment are applied.

Careful examination of energy consumption in the building sector, which is about 39% of the final energy consumption in EU-28 is needed in order to identify the specific areas for energy savings. Due to improved insulation levels of buildings this saving potential moves to more dynamic energy use sectors such as gains from appliances, high energy demand and consumer behaviour. Today, more and more data related to building and building components originate from outdoor testing under time-varying and dynamic conditions, or from real life use of buildings. Dynamic evaluation methods are techniques to analyze time series of data related to dynamic processes and to identify typical parameters of the physical processes for evaluation.

The main purpose of this summer school is to train the students in a methodology for evaluation of measured data. Many of the dynamic methods can be seen as techniques which bridge the gap between physical and statistical modelling. During the summer course, information on relevant software will be given and software tools will be used in the exercises. See also www.dynastee.info the document *Software techniques applied to thermal performance characteristics* some further information about methods and tools is given as well as on benchmark data for testing these methods.

Five enthusiastic lecturers will teach methodologies in >10 presentations for assessing the heat transfer characteristics of building envelopes as well as whole building using data for hands-on exercises.

Among topics that will presented during the week-long Summer School will be:

- Data; first steps for evaluation by plots, graphical examination, common sense, average method and final data selection
- Correlation and statistics from the available data for model development
- Dynamic versus static analysis and physical versus statistical perspective
- General regression techniques
- Methods and models; Output error (OEM) and Prediction error (PEM) methods
- Residual analysis and feedback for model development
- LORD tool and the R-routines in the R-environment (somewhat linked to MatLab-SIT)
- Benchmark data-series; from simulated data for conductive heat transfer to real data for dynamic features of heat transfer
- CEN-ISO standards for heat transfer assessment

The cost for the week-long Summer School is **400 Euro**[1]. This covers:

- Handout of lecture notes and relevant papers
- Lunch (during lecture period) - Coffee etc. (at breaks)
- Social event on Wednesday afternoon

[1] Participants from INIVE registered members receive 50% discount

The deadline for submission is 1st June 2017.

Registration
For registration and communication with the students, download and upload of documents, etc. the organisers are using the services of CIEMAT - PSA.

Participants should do a pre-registration by sending a notification to Carmen Montesinos;
e-mail: cmontesinos.serviciosexternos@psa.es

For further information follow the DYNASTEE web-site; www.dynastee.info

Obligatory homework
The lecturers would like to get insight into the competence of the students at the start of the Summer School week.
Homework has been prepared for the participants in order to a get a minimum homogeneous starting level with the objective of optimising the usefulness of lectures.

Participants will be asked to solve as homework a proposed common wall-exercise and report step by step, the analysis and validation carried out as clearly as possible. These reports must be submitted to the organisers before the start of the Summer School. In addition some reading material will be made available at the web-site.

Lectures
Building Physics and Mathematical Models.
Lectures (>10) will provide the necessary background information on building physics to support the development of mathematical models for energy performance assessment. This includes basic knowledge of thermodynamic processes, in particular heat transfer and the impact of solar radiation. Topics like thermal conduction, convection and radiation will be presented as well as thermal mass. Using data-series for analysis the students will be introduced to the complexity of the physical process and how to translate the available information in mathematical models, e.g. the importance of model simplification of building physics represented by measured signals.
Also the issue of standardisation will be presented, e.g. laboratory testing of building products and in-situ measurements for building element and whole building energy performance assessment.

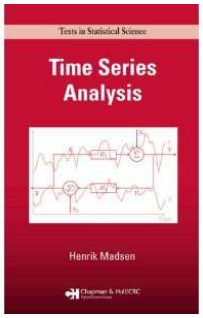
Software
*Note that the software used during the Summer School is the tool LORD as well as routines in **R**. The latter is a free software environment for statistical computing and graphics.*

*Find on the internet more information on **R** http://www.r-project.org/ and **RStudio** http://www.rstudio.com / (open source software).*

It would be wise to study the basics of the software when you want to get the best out of the Summer School week.

Examples will be presented and discussed for LORD and R routines.

LORD is available on request and runs on Windows systems. Please sent an e-mail to hans.bloem@ec.europa.eu



DTU Compute

DTU

Models and model building

Linear transfer function models. Topics such as identification, formulation, estimation, and validation are presented. Furthermore, impulse response models, transfer function models, ARX, ARMAX and Box-Jenkins models and how to use these techniques to estimate values like the UA-value, gA-value and time constants of a building or a component will be covered.

Linear and non-linear state-space models. Topics such as identification, formulation, estimation, validation and Kalman Filter techniques are presented. In addition, lumped parameter models, RC-models, models, and combining information from data with prior information from physics are presented. Participants will learn how to use these techniques to estimate detailed physical quantities like the heat capacitance, window areas, solar aperture, effect of wind speed, nonlinear heat transfer, and non-stationary heat transfer.

Simulation, Prediction and Control. A short introduction will be given on the representation of physical models within simulation programs and the use of these for prediction and control. This will include consideration of uncertainty in inputs and algorithms. .

How to obtain results using different models and methods.

The presented analysis and validation approaches will be illustrated step by step using a very simple and well documented case study. The tool LORD will be used as well as routines in the R-environment.

The U value of a simple building component will be estimated using different analysis approaches for hands-on examples through exercises. This will guide students through the application of different analysis approaches. These examples are designed to provide participants with the skills to apply the different techniques of modelling and validation. The aim is to put the focus on these techniques rather than on the component itself which is facilitated by the simplicity of this component. The different approaches will be presented "bottom up", starting from the simplest, and gradually increasing complexity highlighting and discussing the main features added by each level of the corresponding modelling approach. The following approaches will be considered: average and pseudo-dynamic methods, transfer function models (using the statistical software R) and continuous-time state space models (CTSM-R).

Modelling building components and whole buildings.

In this part the potential of the tools presented within the course to model building systems will be demonstrated. The modelling of building components and whole buildings are presented as examples. All the complementary aspects of their analysis will be described in detail.

It will be emphasised that once sufficient skill in using tools are achieved, they must be combined with physical knowledge and understanding of the physical system, to pick all relevant influences and simplify them when necessary to find optimum models. The implementation of the different physical assumptions in different continuous-time state space models is presented step by step. The performance of each considered model is analysed and discussed.

Preliminary programme.

The daily programme is organised around lectures and exercises each morning and afternoon session.

The week-long programme offers >10 lectures and as much time for exercises as possible and a dedicated lecture by an invited expert.

The first day is focused on the homework that should be presented by each participant, highlighting the solutions and problems in the approach of solving the wall exercise.

What we expect from you

1) Hand in the solution to a preparation exercise before the Summer School starts. The exercise aims to introduce the software R and some basic time series modelling principles.
2) Follow the Summer School for all 5 days, 3rd to 7th July 2017 in Granada, Spain.

For European students, 2.5 ECTS could be assigned upon request.

Note that you have to bring your own computer, preferably having installed the software environment R and R-Studio. LORD will be made available upon request.

Date: 3 - 7 July 2017 in Granada

Venue: The Summer School will take place at the
Escuela Técnica Superior de Arquitectura de la Universidad de Granada
Address: Plaza Campo del Principe s/n, Granada

Granada can be reached in different ways.
See http://www.granadainfo.com/granadatravel.htm

Note that DYNASTEE has organized a block booking for **LODGE "LA CORRALA DE SANTIAGO". Valid until end of 31 May.** The Lodge is < 5 minutes walk away. A pre-reservation of single rooms has been done at (http://corraladesantiago.ugr.es).
To confirm this reservation, 50% payment of the total booking is an essential requirement.
However you are always free to do your own hotel booking

You are advised to use the **registration forms** for the Summer School 2017 and the hotel which will be sent to you after pre-registration.

Social Event

Wednesday 5 July.
An event is organised for all participants.
Details will follow.

Previous Summer Schools organized by DYNASTEE

Have a look at the DYNASTEE web-site http://dynastee.info/ for an impression of the Summer School 2012 in Denmark, 2013 in Spain, 2014 in Belgium, 2015 in Denmark and last year in Granada, Spain.
You may find further information in the latest DYNASTEE Newsletters on the web-site.

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How to register to the Summer School 2017?

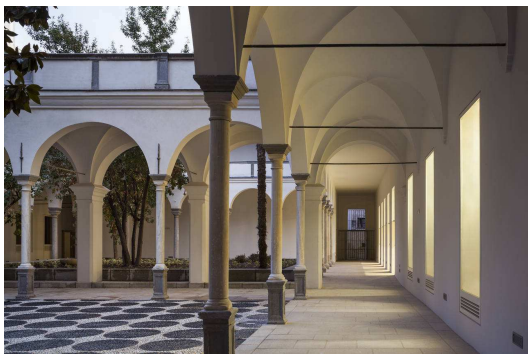
The deadline for submission is 1st June 2017.

Pre-registration for the Summer School on *"Dynamic methods for whole building energy assessment*" is simple. Participants should do a pre-registration by sending a notification to Carmen Montesinos; e-mail: cmontesinos.serviciosexternos@psa.es

The cost for the week-long Summer School is **400** Euro[2]. Carry out the payment as instructed in the separate form that will be sent to you after pre-registration.
Note that the Summer School requires a minimum of 16 registered participants by 1st of June 2017 and that it is limited, for practical reasons, to 30 participants.

Additional information
For further information on the content of the course, please contact:
Hans Bloem hans.bloem@ec.europa.eu,
Maria Jose Jimenez mjose.jimenez@psa.es,
Henrik Madsen hmad@dtu.dk
Paul Strachan paul@esru.strath.ac.uk

For further information on practical issues potential participants can contact:
Hans Bloem hans.bloem@ec.europa.eu



UGR Granada

The University of Granada (http://www.ugr.university) was founded in 1531, and built on a longstanding teaching tradition, the roots of which can be traced back to the madrasahs of the Nasrid kingdom of Granada. With over 60,000 undergraduate and postgraduate students and 6,000 staff, the UGR constitutes a powerful presence in a city of 250,000 inhabitants. The University is the highest-ranked in the South of Spain, in both research and education.
Granada School of Architecture (http://etsag.ugr.es/) was founded in 1995 and in the spring of 2015 it recovered its headquarters in the old Military Hospital in Campo del Príncipe, a square located in the heart of the Realejo neighborhood, within the historic center of the city. The rehabilitation competition of the building, originally a 16th century Renaissance palace, was won by the architect Víctor López Cotelo. The project has been awarded with the National Prize of Spanish Architecture 2015.

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