SUMMER SCHOOL 2016

19 – 24 JUNE 2016, Granada, Spain

Dynamic Methods for whole Building Energy Assessment

ugr Universidad de Granada

ETS INGENIERÍA DE CAMINOS CANALES Y PUERTOS

Deadline for submission is 15th May 2016

Organised by: DYNASTEE-INIVE and CITIES and the Civil Engineering School (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, Peder Bacher (DTU, Lyngby, Denmark), Paul Strachan (Strathclyde University, Glasgow, UK).

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FIRESAFE INSULATION

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

CITIES

DELIVERING LOW ENERGY BUILDINGS THAT WORK IN REALITY!

*"The first step towards real performance is to recognise, identify and address the gaps that exist between what is known and what needs to be known. That is why **Knauf Insulation** is supporting this Summer School, so that together with leading academics in the field, we can take our collective responsibility to ensure that we move rapidly towards buildings that really perform"*

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it's time to save energy

University of Strathclyde Engineering

GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

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CITIES Centre for IT Intelligent Energy Systems

Technical University of Denmark DTU

DYNASTEE INIVE

Introduction

After 4 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.

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. Data from smart meters are typical examples of such time series and provides details of energy usage patterns.

The main purpose of this summer school is to train the students in a methodology for evaluation of measured data. Statistical modelling methods for using such time series data are discussed to assess valuable information about the energy performance of a building or the building element. An introduction to essential statistical techniques for model evaluation and selection are given with examples and through exercises. 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. Specifically the focus will be on how to extract essential performance parameters of buildings using these models and techniques.

It will be shown that dynamic analysis methods linked to appropriate models can give rather detailed information about the various components of a building. The important aspects of applying models with a suitable complexity depending on the data are highlighted.

PhD students might be interested to know that 2.5 ECTS are awarded for attendance at this Summer School. The initial programme contains 5 parts:

1. Homework (the participants will have to arrive a bit prepared).
2. Building physics and mathematical models.
3. Theory about models (AR(MA)X, grey-box, etc.), modelling using time-series analysis and statistical validation with software.
4. Guidelines for analysis; physics and statistics
5. Thermal balance and physical characteristics of building elements.

The cost for the week-long Summer School is **400 Euro**[1]. This covers:
- Handout of lecture notes and relevant papers
- Access to DTU CampusNet from moment of registration
- 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 15th May 2016.

DTU CampusNet
For registration and communication with the students, download and upload of documents, etc. the organisers are using the services of the Danish Technical University.
For further information see the DTU web-site:
http://energy.imm.dtu.dk/summer-schools/dynamic-calculation-methods-for-building-energy-assessment.html

After payment of the Summer School you will get access to the **DTU CampusNet** for a limited period of time (end of the year) at https://campusnet.dtu.dk/

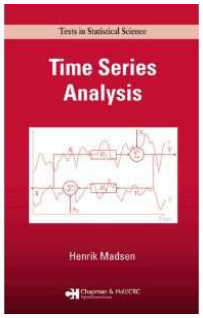
Obligatory homework
The lecturers would like to get insight into the competence of the students at the start of the Summer School week.
Homework has been prepared for the participants in order to a get a minimum homogeneous starting level with the objective of optimising the usefulness of lectures.
An introduction to **R** and simple linear regression exercise is given as obligatory preparation. 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

Lectures
Building Physics and Mathematical Models.
Lectures 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 **R**. It 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 **R** when you want to get the best out of the Summer School week.*

Examples will be presented and discussed for R and CTSM-R.
***CTSM-R** is an R package in which an updated version of the Continuous Time Stochastic Modelling (CTSM) software is implemented. It can be used for grey-box modelling and provides a very powerful framework for combined physical and statistical modelling.*

Go to www.ctsm.info the homepage of CTSM-R for more information. Go to the /pdfs/userguide.pdf



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 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 (using 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 skills 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.

For PhD students 2.5 ECTS points can be acquired.
In order to receive 2.5 ECTS credits at PhD level through DTU, the students must:

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 6 days, 19nd to 24th June 2016 in Granada, Spain.
3) Hand in a report for relevant exercises carried out during the Summer School (appropriate time with assistance is reserved for carrying out the exercises).

Note that you have to bring your own computer, preferably having installed the software environment R and R-Studio.

Date: 19 - 24 June 2016.

Venue: The Summer School will take place at the Civil Engineering School (University of Granada, Spain). Granada can be reached in different ways.
See http://www.granadainfo.com/granadatravel.htm
Note that DYNASTEE has organized a block booking for
Hotel Granada Center, situated in front of the university.
You could use the hotel **registration form** at the last page of this flyer.

However you are always free to do your own booking

Social Event

Wednesday 23 June.
A visit to the Alhambra followed by a social diner in the center of Granada is organised for all participants.

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 and again in Denmark in 2015.
You may find further information in the latest DYNASTEE Newsletters on the web-site.

SPONSORS

DYNASTEE INIVE

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KNAUF INSULATION it's time to save energy

How to register to the Summer School 2016?

The deadline for submission is 15th May 2016.

Registration for the Summer School on *"Dynamic methods for whole building energy assessment*" is simple. See the website:

http://energy.imm.dtu.dk/summer-schools/dynamic-calculation-methods-for-building-energy-assessment/general-information.html

The cost for the week-long Summer School is **400** Euro[2]. Carry out the payment as instructed on the CampusNet website.

Additional information

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

For further information on practical issues like accommodation, hotel reservation and logistics, potential participants can contact: Hans Bloem hans.bloem@jrc.ec.europa.eu
Note that the Summer School requires a minimum of 16 registered participants by 15th of May 2016 and that it is limited for practical reasons, to 30 participants.

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.
The Civil Engineering School was built in 2000 and leads the training of Civil Engineering in Andalusia. It is a modern building with the most advanced research laboratories and students equipment in the UGR.

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ACCOMMODATION

BOOKING

Remit to VIAJES EL CORTE INGLES, S.A. C/ Plaza Manuel Cano, s/n. 18004. Granada. Tf: +34.958 20 85 05

Fax: +34.958 203090 E-mail: granadaempresas@viajeseci.es, Until/before **20 April 2016**

PERSONAL INFORMATION

Surname:_____Name:_____

Adress:_____

Zip :_____City:_____Telephone :_____

FAX:_____E-MAIL:_____

ACCOMMODATION RATES

All prices are per night, vat included.

HOTEL		DOUBLE ROOM	SINGLE ROOM
GRANADA CENTER ****	ONLY ROOM	64,27 €	64,27 €
	INCLUDED BREAKFAST	80,00€	70,00 €

BOOKING

DOUBLE ROOM:_____SINGLE ROOM : _____

ARRIVAL DATE:_____DEPARTURE DATE _____NIGHTS:_____

REMARKS: _____

FORM OF PAYMENT:

Transferencia Bancaria a / *Bank Transfer to*:

Desde España/*Within Spain*:	Desde el Extranjero/*International Transfer*:
Viajes El Corte Inglés, S.A.	Viajes El Corte Inglés, S.A.
Banco Santander Central Hispano	Bank BBVA
0049-1500-06-2510011350	0182-3994-07-0000664047
Plaza Canalejas, 1 – 28014 Madrid	Paseo de Recoletos, 10 – 28001 Madrid (Spain)

Imprescindible enviar por fax copia de la transferencia/*It is essential to send us by fax the bank transfer copy*

Con cargo a la tarjeta: ⎕ VISA ⎕ MASTER CARD ⎕ AMERICAN EXPRESS ⎕ EL CORTE INGLES

Nº _____Expiration Date: _____

Holder: _____Passport Number : _____

Total Amount _____ €

Date: _____ Signature: _____