Course guide
310405 - 310405 - Prediction Models in Building Construction

Last modified: 24/11/2023

Unit in charge:	Barcelona School of Building Construction
Teaching unit:	749 - MAT - Department of Mathematics.

Degree:	MASTER'S DEGREE IN ADVANCED BUILDING CONSTRUCTION (Syllabus 2014). (Compulsory subject).

Academic year: 2023   **ECTS Credits:** 5.0   **Languages:** Spanish

LECTURER

Coordinating lecturer:	ANTONI GUILLAMON GRABOLOSA
Others:	Guillamon Grabolosa, Antoni Serrat Pie, Carles

PRIOR SKILLS

It is important that students have prior knowledge of a basic university course both in linear algebra and in differential calculus in one and several variables. It is also convenient to have a basic knowledge on statistics and programming.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
6. Use the physic principles in the thermic, luminic and acoustic scope.

Generical:
9. Prepare to communicate with efficiency, orally but also in written.
10. Prepare the student in the using of tools that are common in the investigation activities, like the analysis and treatment of data, just like methodology and investigation techiniques.
11. Develop and/or apply ideas with originality in a context of investigation, identifying and formulating hypothesis or innovative ideas and submit them to a objectivity, coherence, and viability test.

Transversal:
7. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
8. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.

Basic:
3. The students must be able to apply the acquired knowledges and their ability of resolution of problems in new or little known environments inside more wide environments (or multidisciplinary) related with their study field.
4. The students must be able to integrate knowledges and front to the complexity to formulate opinions from an information which, being incomplete or limited, includes reflections about the social and ethical responsabilities linked to the application of their knowledges and opinions.
5. The students must be able to communicate their conclusions and the knowledges and ultimate reasons which support to specialised and non-specialised audiences in a clear mode and without ambiguities.
1. The students must possess the learning abilities which allow them to continue studying in a way which should be to a large extent self-directed and autonomous.

TEACHING METHODOLOGY

The hours of directed learning are organized in lectures, problem classes and practical sessions with a computer.

The lectures introduce the learning objectives and the general basics of each of the course topics and they are illustrated by the resolution of practical examples to motivate the active participation of the student learning.

Laboratory sessions can be done in the computer room or in the regular classroom with the student's laptop. Minitab and MATLAB software will be used for data analysis and problem solving. The sessions develop the practical section of the subject and the concepts and methods related to the contents that are being studied.

The basic documentation for both the theoretical descriptions and practical problems can be found in Atenea.

We must also consider other hours of independent learning by students such as those devoted to the study different course topics, extension literature, resolution of problems and the proposed monitoring practices in the laboratory.

LEARNING OBJECTIVES OF THE SUBJECT

Passed the course the student will be able to implement the processing of data (with the most appropriate computing resources) a mathematical prediction model using differential equations and statistics tools.

STUDY LOAD

Type	Hours	Percentage
Hours small group	5,0	4.00
Hours large group	17,5	14.00
Hours medium group	5,0	4.00
Self study	90,0	72.00
Guided activities	7,5	6.00

Total learning time: 125 h

CONTENTS

B1. Differential equations and dinamical systems

Description:

1.1. Modeling using differential equations.
Partial and directional scalar fields; functions operators (gradient, divergence and Laplace) and their physical meaning; models of ordinary differential equations and partial differential equations in building construction.

1.2. Methods of analysis and solution of ordinary differential equations (ODEs).
Linear stability analysis of stationary solutions. Methods of numerical integration of ODEs. Applications to the resolution of models depending on parameters (bifurcation diagrams).

1.3. Numerical solution of partial differential equations (PDEs).
Numerical linear algebra. Discretization of the space. Finite difference methods. Methods of numerical integration of EDPs. Simulation and interpretation of the heat equation.

Specific objectives:

In this block we work concepts and mathematical techniques needed to address several problems in building enclosures as thermal behavior, fire spread or leaks in water distribution networks, among other subjects that will be studied in the Master. The mathematical treatment of these problems involves modeling using ordinary differential equations and partial, often coupled with each other, the linear stability analysis and computation of solutions to the problem using numerical methods. It aims to provide students with the basic cultural understanding these models and tools, and enable them to numerical simulation and its representation through existing programs.

Related activities:

Sessions consist of a theoretical part and a practical part which will be carried out to the computer room. The completion of these proposals is the basic qualification element with a rating of the 70% of the block. The evaluation is completed with a conceptual test at the end of the block (30%).

Related competencies :

CG2. Prepare to communicate with efficiency, orally but also in written.
CG3. Prepare the student in the using of tools that are common in the investigation activities, like the analysis and treatment of data, just like methodology and investigation techiniques.
CE3. Use the physic principles in the thermic, luminic and acoustic scope.
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.

Full-or-part-time: 62h 30m
Theory classes: 7h 30m
Practical classes: 7h 30m
Guided activities: 10h
Self study : 37h 30m

B2. Multivariate analysis

Description:
2.1 Descriptive statistics and the Normal distribution
Centralization and dispersion parameters. Graphic representation: Boxplots and histograms. Introduction to Minitab. Normal distribution. 68-95-99 rule.

2.2 Statistical Inference.
Confidence intervals and hypotheses tests. Type I error and Type II error.

2.3. Multiple linear regression model.
Definition of linear adjustment. Estimation and prediction. Qualitative predictors. Residual analysis. Autocorrelation.

2.4. General linear model.
Modeling of nonlinear relationships. Interaction between predictors. Transformations of the answer. Determination of the model.

2.5. ANOVA-MANOVA
The main objective of the analysis of variance (ANOVA) is to show significant differences between different averages. This is achieved by dividing the total variance into a component that is due to certain random error (within the group) and other components that are due to the differences between the averages (beetwen groups). The multivariate analysis of MANOVA variance is an extension of ANOVA methods to cover cases in which there is more than one dependent variable.

Specific objectives:
This block presents the definitions and mathematical language needed to describe the basics and models of multivariate analysis. These concepts will be used to solve problems of estimating regression models and analysis of variance (ANOVA or MANOVA). The aim is for the student to acquire the ability to select reliable and valid measures, choose the right software, use it correctly, and know how to interpret the results.

Related activities:
Sessions will consist of a theoretical part and a practical part in which a proposal will be made in the computer room. Completion of these proposals will be the basic qualification element of this block (70%). It will be completed with a theoretical-practical test at the end of the block (30%).

Related competencies :
CG2. Prepare to communicate with efficiency, orally but also in written.
CG4. Develope and/or apply ideas with originality in a context of investigation, identifying and formulating hypothesis or innovative ideas and submit them to a objectivity, coherence, and viability test.
CG3. Prepare the student in the using of tools that are common in the investigation activities, like the analysis and treatment of data, just like methodology and investigation techinques.
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.

Full-or-part-time: 62h 30m
Theory classes: 7h 30m
Practical classes: 7h 30m
Guided activities: 10h
Self study : 37h 30m

GRADING SYSTEM

The evaluation of the course is designed so that each block is evaluated separately. Each block, B1 and B2, will have a unique score obtained from a theoretical and a practical proposal carried out in the computer room during the laboratory classes. The completion of these proposals is the basic qualification element with a rating of the 70% of the block. The evaluation is completed with a theory-practice based test at the end of the block (30%).

The final score, Nf is Nf=(B1+B2)/2.

All marks are calculated on a 10 points basis.

EXAMINATION RULES.

Not attending to any of the tests will be graded with a zero.

BIBLIOGRAPHY

Basic:
- Johnson, Richard A; Wichern, Dean W. Applied multivariate statistical analysis. Englewood Cliffs, N.J.: Prentice-Hall, cop. 1982. ISBN 013041400X.
- Montgomery, Douglas C; Runger, George C. Probabilidad y estadística aplicadas a la ingeniería. México [etc.]: McGraw-Hill, 1996. ISBN 9701010175.
- Clarke, J. A. Energy simulation in building design. 2nd ed. Oxford: Butterworth Heinemann, 2001. ISBN 0750650826.
- Golubitsky, Martin ; Dellnitz,Michael. Álgebra lineal y ecuaciones diferenciales con Matlab. México: Thomson Learning, 2001. ISBN 9706860401.
- Burden, Richard L. ; Faires, J. Douglas. Análisis numérico. 9a ed. México DF: Cengage Learning, 2011. ISBN 9786074816631.
- McKenzie, John; Goldman, Robert N. The student edition of Minitab for Windows user's manual : release 12. Reading, [MA] [etc.]: Addison-Wesley, cop. 1999. ISBN 9780201397116.

RESOURCES

Computer material:
- Minitab. Resource
- MATLAB. Resource

Hyperlink:
- pàgina web de Minitab. Resource
- pàgina web de Matlab. https://es.mathworks.com/products/matlab