COURSE SYLLABUS
2016-2017

GENERAL INFORMATION

Course information	
Name	Forecasting methods and applications
Code	MRE-514
Degree	Master's Degree in Research in Engineering Systems Modeling (MRE)
Year	
Semester	1st (Fall)
ECTS credits	3 ECTS
Type	Elective
Department	Electronics, Automation and Communications
Area	Electronics-Signal Processing
Coordinator	Antonio Muñoz San Roque

Instructor	
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DETAILED INFORMATION

Contextualization of the course

Contribution to the professional profile of the degree

Engineers are very often involved in decision-making processes where decisions about the future may be taken from the analysis of information about the past. In these situations, forecasting techniques become essential tools for the treatment of uncertainty. For example, from the point of view of Operations Management, organizations routinely use forecasts of product sales or demand for services in order to schedule production, control inventories, manage the supply chain, determine staffing requirements, and plan capacity.

The main objective of this introductory course on time series forecasting is to learn and apply statistical methods for the analysis of data that have been observed over time. By the end of the course, students will understand the basic principles behind time series analysis and forecasting and will have gained a strong practical experience in the identification, adjustment and validation of time series models using software tools.

Prerequisites

Students willing to take this course should be familiar with linear algebra, basic probability and statistics. Previous experience with MATLAB is also desired although not strictly required.

CONTENTS

Competences and Learning Outcomes

Competences

General Competences

CB1. Having acquired advanced knowledge and demonstrated, in the context of scientific, technological or highly specialized research, a solid and specialized understanding of theoretical and practical aspects as well as the work methods in one or more fields of study.

Basic Competences

Specific Competences

CE9. Mastering the techniques, methods and/or tools needed to cover a research topic in a specific sector or technological context.

Learning outcomes

By the end of the course students should be able to:

RA1. Identify and describe the nature and fundamental characteristics of time series.
RA2. Identify and describe the structure and fundamental characteristics of the basic models used in time series forecasting.
RA3. Determine the most appropriate techniques to be used for the identification of the basic models used in time series forecasting.
RA4. Determine the most appropriate techniques to be used for the validation and diagnosis of the basic models used in time series forecasting.
RA5. Demonstrate a strong practical experience in the identification, estimation and validation of models for predicting time series using statistical software.

TEACHING METHODOLOGY

General methodological aspects	
The best way of gaining a full understanding of forecasting techniques is implementing them and facing real challenges. Consequently, all the proposed activities focus on providing students with the tools they require to be able to successfully develop a forecasting model by the end of the term.	
In-class activities	**Competences**
▪ **Lectures and problem-solving sessions (12 ho urs)**: The lecturer will introduce the fundamental concepts of each chapter, along with some practical recommendations, and will go through worked examples to support the explanation. Active participation will be encouraged by raising open questions to foster discussion and by proposing short application exercises to be solved in class either on paper or using a software package.	RA1, RA2, RA3, RA4, RA5
▪ **Lab sessions (16 hours):** Under the instructor's supervision, students, divided in small groups, will apply the concepts and techniques covered in the lectures to real problems and will become familiar with statistical software tools.	RA1, RA2, RA3, RA4, RA5
▪ **Final project presentations (2h):** students will perform a presentation of their final project to the rest of the class. During the presentation, the instructor and students may ask questions that should be answered by the speakers.	RA1, RA2, RA3, RA4, RA5
▪ **Tutoring** for groups or individual students will be organized upon request.	–
Out-of-class activities	**Competences**
▪ Personal study of the course material and resolution of the proposed exercises (24 hours).	RA1, RA2, RA3, RA4
▪ Lab results analysis and report writing (24 hours).	RA1, RA2, RA3, RA4, RA5
▪ Development of a final project in small groups during the last third of the course (12 hours).	RA1, RA2, RA3, RA4, RA5

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Weight
Participation in class	▪ Understanding of the theoretical concepts. ▪ Active participation.	10%
Lab reports	▪ Application of theoretical concepts to real problem-solving. ▪ Critical analysis of numerical results. ▪ Ability to use and develop computer vision software. ▪ Written communication skills.	30%
Final project	▪ Problem analysis. ▪ Quality of the proposed solution. ▪ Critical analysis of numerical results. ▪ Oral presentation and written communication skills.	60%

GRADING AND COURSE RULES

Grading

Regular assessment

- Participation in class: 10%
- Lab reports: 30%
- Final project: 60%

In order to pass the course, the mark of the final project must be at least 5 out of 10 points.

Course rules

Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Comillas Pontifical University and Article 6 of the Academic Rules (Normas Academicas) of the ICAI School of Engineering.

Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (Reglamento General) of Comillas Pontifical University).

WORK PLAN AND SCHEDULE[1]

In and out-of-class activities	Date/Periodicity	Deadline
Lab sessions	Weekly	
Review and self-study of the concepts covered in the lectures	After each lesson	–
Problem-solving	Weekly	–
Lab preparation	Before every session	–
Lab report writing	–	One week after the end of each session
Final project	During the last third of the course	Last week

STUDENT WORK-TIME SUMMARY			
IN-CLASS HOURS			
Lectures	Problem-solving	Lab sessions	Assessment
12	-	16	2
OUT-OF-CLASS HOURS			
Self-study	Lab preparation	Lab report writing	Final project
24	4	20	12
		ECTS credits:	3 (90 hours)

BIBLIOGRAPHY

Basic bibliography

- Notes prepared by the lecturer (available in Moodle).
- "Time series analysis. Univariate and Multivariate Methods". William W.S. Wei. 2nd edition. Pearson Addison Wesley. 2006.

Complementary bibliography

- "Introduction to Time Series and Forecasting". Peter J. Brockwell and Richard A. Davies. Springer. 1996
- "Introduction to Time Series Analysis and Forecasting". Douglas C. Montgomery, Cheryl L. Jennings and Murat Kulahci. John Wiley & Sons, Inc. 2008.
- "Forecasting with Dynamic Regression Models". Alan Pankratz. Wiley-Interscience. 1991
- "Time Series Analysis: Forecasting & Control". 3ª Ed. G. Box, G.M. Jenkins, G. Reinsel. Prentice Hall. 1994
- "Análisis de series temporales". Daniel Peña. Alianza Editorial. 2005

[1] A detailed work plan of the subject can be found in the course summary sheet (see following page). Nevertheless, this schedule is tentative and may vary to accommodate the rhythm of the class.

	IN-CLASS ACTIVITIES				OUT-OF-CLASS ACTIVITIES				LEARNING OUTCOMES
Week	h/w	LECTURE & PROBLEM SOLVING	LAB	ASSESMENT	h/w	SELF-STUDY	LAB PREPARATION AND REPORTING	OTHER ACTIVITIES	Learning Outcomes
1	2	Introduction (1h)	Introduction to IDAT (1h)		4	Review and self-study (2h)	Practice with IDAT stastistical software (2h)		RA1, RA5
2	2	Fundamental Concepts (1h)	Lab Practice 1 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
3	2	Exponential Smoothing methods (1h)	Lab Practice 2 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
4	2	ARIMA models I (1h)	Lab Practice 3 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
5	2	ARIMA models II (1h)	Lab Practice 4 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
6	2	ARIMA models III (1h)	Lab Practice 6 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
7	2	Transfer Function models I (1h)	Lab Practice 7 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
8	2	Transfer Function models II (1h)	Lab Practice 8 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
9	2	Intervention analysis and outlier detection (1h)	Lab Practice 9 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
10	2	GARCH models (1h)	Lab Practice 10 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
11	2	Nonlinear models (1h)	Lab Practice 11 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
12	2	Combination of forecasts (1h)	Lab Practice 12 (1h)		4	Review and self-study (2h)	Lab preparation and report writing (2h)		RA1, RA2, RA3, RA4, RA5
13	2		Final project (2h)		4			Final project (4h)	RA1, RA2, RA3, RA4, RA5
14	2		Final project (2h)		4			Final project (4h)	RA1, RA2, RA3, RA4, RA5
15	2			Final project presentations (2h)	4			Paper and presentation preparation (4h)	RA1, RA2, RA3, RA4, RA5