Course guide
240AR013 - 240AR013 - Modelling, Identification and Simulation of Dynamical Systems

Last modified: 16/05/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: MASTER'S DEGREE IN AUTOMATIC CONTROL AND ROBOTICS (Syllabus 2012). (Compulsory subject).
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer: BERNARDO MORCEGO SEIX

Others: RAMON PEREZ MAGRANE - JOSEP CUGUERÓ ESCOFET

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
2. The student will be able to identify, obtain models, simulations, analyze and validate simple dynamic systems in adequate representation for the intended purpose (analysis, simulation and design).
3. The student will be able to use analysis tools and computer-aided design of control systems in the tasks usual analysis, simulation and controller design.

Generical:
1. Ability to conduct research, development and innovation in the field of systems engineering, control and robotics, and as to direct the development of engineering solutions in new or unfamiliar environments, linking creativity, innovation and transfer of technology

TEACHING METHODOLOGY

face-to-face classes:
- Lectures (MD 1)
- Cooperative learning (MD 3)

Non face-to-face classes:
- Autonomous learning (MD 2)
- Case based learning (MD4)

LEARNING OBJECTIVES OF THE SUBJECT

Learning Outcomes
- Use the concepts and basic tools of modeling, identification and dynamic system simulation
- Use the basic software to analyse control systems, as well as and modelling of dynamic systems

Mandatory Contents:
- Model identification methodology
- Parametric estimation techniques of linear and non linear models

STUDY LOAD

Type	Hours	Percentage
Hours large group	20,3	18.03
Hours small group	20,3	18.03
Self study	72,0	63.94

Total learning time: 112.6 h

CONTENTS

Mathematical and computational modeling

Description:
External and internal representation of dynamic systems
Representation of continuous and discrete systems
Linear and nonlinear representation of dynamic systems
Representation of uncertainty
Computational representation of dynamic systems for simulation

Related activities:
Activities 1, 2, 3 and 5

Full-or-part-time: 60h 15m
Theory classes: 11h 30m
Laboratory classes: 6h
Guided activities: 6h
Self study : 36h 45m

Identification of dynamic systems

Description:
Prediction and simulation models
Identification of linear models
Identification of linear parameter varying models
Identification of nonlinear models
Validation of models and design of experiments

Related activities:
Activities 1, 3, 4 and 5

Full-or-part-time: 52h 15m
Theory classes: 11h 30m
Laboratory classes: 4h
Guided activities: 2h
Self study : 34h 45m

ACTIVITIES

1. THEORY LECTURES

Description:
Exposition of the contents of the subject theory contents following an expositive and participative model of class.In this class, problems will be solved with all the group.

Specific objectives:
Knowledge transfer, creation of a conceptual reference frame, solving questions and generating interest about the subject.

Material:
Compilation of slides and notes at Atenea
General bibliography of the subject

Delivery:
This activity is evaluated together with activities 2 and 5

Full-or-part-time: 28h
Theory classes: 21h
Self study: 7h

2. EXERCISES SESSIONS

Description:
Exercises and problems are discussed with the students. These problems will have been previously thought about by the students

Specific objectives:
Understanding and acquisition of skills with the concepts explained at theory lectures

Material:
Collection of exercises at Atenea

Delivery:
The resolution of some problems are evaluated.

Full-or-part-time: 30h
Practical classes: 10h
Self study: 20h

3. LABORATORY EXERCISES

Description:
Groups of two people follow the instructions to resolve an identification and/or simulation problem. These sessions take place at the lab and there are five sessions.

Specific objectives:
Proper application of identification and simulation methodologies to dynamic systems.

Material:
Lab exercises at Atenea
Simulation software (Matlab)
Notes of the subject

Delivery:
Each group has to deliver a report answering the questions of the exercise and justifying the answers.

Full-or-part-time: 12h
Guided activities: 8h
Self study: 4h

4. CASE OF STUDY

Description:
A case of study is carried out in groups of two students.

Specific objectives:
Proper application of the concepts and principles given in theory modules one and two.

Material:
Case description and resolution methodology instructions at Atenea
Simulation software (Matlab)
Notes of the course

Delivery:
A report with the results of the case of study and the justifications that led to those results will have to be delivered.

Full-or-part-time: 12h
Self study: 12h

5. FINAL EXAMINATION

Description:
Written individual examination about the concepts of theory modules one and two. The examination includes short answer or test questions, problems to be solved by hand and computer exercises.

Specific objectives:
Demonstrate the level of achieved knowledge in the activities 1, 2, 3 and 4.
Activities 3 and 4 are also evaluated individually to distinguish from the group evaluation.

Material:
Examination instructions

Delivery:
Resolution of the test, in the same sheet of the exam

Full-or-part-time: 30h 30m
Theory classes: 2h
Self study: 28h 30m

GRADING SYSTEM

The acquired competences and abilities will be evaluated on the basis of four concepts: problems resolution (15%), practical session questionnaires (25%), final assignement report (15%) and final exam (45%).
Extraordinary evaluation will follow the School rules and it will substitute the final exam.

EXAMINATION RULES.

The written and practical exam will be carried out individually and without notes. The questions, tests, problems and small reports are the result of the autonomous learning or of the activities of the practices. They consist on the delivery of a written document with the resolution of a problem set in class or proposed on the exercise book of the course or proposed on the formulation of the practices and worked in this sessions.
The formal reports correspond to the resolution of an applied problem. It consits on a document written by the group carrying out the activity. A formal structure and the resolution of the problem regarding to the formulation of the same must be followed.

BIBLIOGRAPHY

Basic:
- Ljung, Lennart; Glad, Torkel. Modeling of dynamic systems. Englewood Cliffs: PTR Prentice Hall, 1994. ISBN 0135970970.
- Ljung, Lennart. System identification : theory for the user. 2nd ed. Englewood Cliffs: Prentice-Hall, cop. 1999. ISBN 0136566952.

Complementary:
- Nørgaard, Magnus. Neural networks for modelling and control of dynamic systems : a practitioner's handbook. London: Springer-Verlag, 2000. ISBN 1852332271.