Systems Dynamics

Course ID: 267MI – Fall 2018

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267MI –Fall 2018

Course Overview

Course administration

Lecturers & examiners

- Thomas Parisini (t.parisini@gmail.com)
- Gianfranco Fenu (fenu@units.it)

Course home page

- slides, exercises and computer code examples
- old exams

http://control.units.it

Course credits

- 9 CFU

Examination

- **Final exam**: a preliminary written examination followed by oral questions.
- The **final grade** depends on both the written part and the outcome of the oral discussion.
- Written examination and oral discussion usually usually take during the same exam session.

Examination (cont.)

Written examination

The exam paper consists of 3 – 4 essay questions:

- typical numerical application problems
- specific questions about theoretical aspects (theorems, properties, definitions) could be included

Oral questions

Oral questions deal with any possible topic, discussed and analysed in the lectures.

- A short discussion about the written examination results generally also takes place

Examination (cont.)

Homework (not compulsory)

- Advanced engineering specific projects are offered during the course, characterised by challenges more difficult to address than the usual ones.
- The aim is to stimulate learning advanced concepts during the course also to help the learning exercise
- These projects are then evaluated upon request by the students.
- It's allowed to solve the projects in groups, up to 3 persons.
- Working on homework problems is **not compulsory**

Examination (cont.)

Homework & final grade

- Homework contributes to the final grade, with an increment of the score up to 2 points.
- The grading of the homework is **independent** from the grading of the examination

Exam sessions

Examination timetable

- 3 sessions in January–February
- 3 sessions in June–July
- 1 session in September

How to sign up for examinations

- In order to participate to the exam session you must sign up/register for the exam **(compulsory)**
- To sign up, use the students university career management system Esse3 to access to the on-line University Services.
- Please, **pay attention** to the dates of the registration periods and the examination periods!

Course Information

Prerequisites

- Linear algebra, calculus and complex analysis
- Course 034IN “Fundamentals of automatic control” (or equivalent for students enrolled from other universities/programs)
- Basic knowledge of probability and statistics is not mandatory, but highly helpful

Course organization

- Lectures
- Exercise sessions

Desiderata

Students who pass the course should be able to:

- carry out a complete and comprehensive analysis of the main properties of deterministic and stochastic discrete-time dynamic systems;
- design and implement parametric estimation and identification, and state estimation algorithms that use available data or data collected in real-time with reference to engineering application scenarios;
- . . .

Desiderata (cont.)

Students who pass the course should be able to

- evaluate, among several options, what’s the best choice of parametric estimation and identification, and state estimation algorithms starting from requirements and considering technological constraints;
- describe in a clear and plain way the functionalities of a parametric estimation and identification, and state estimation algorithm in the context of discrete-time dynamic systems and with the correct use of technical terminology

Lecture Plan

Lect.	Content
1	Course overview. Generalities: systems and models (defs, props, problems).
2	Sampling and discrete-time representation of continuous-time dynamic systems.
3	Time-evolution of state and output of linear dynamic systems.
4	Stability of discrete-time dynamic systems.
5	Model identification from data.
6	A glimpse on prob. theory, random vars and discrete-time stochastic processes.
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Lecture Plan (cont.)

Lect.	Content
7	Definitions and properties of the estimation and prediction problems.
8	Dynamic models of stationary discrete-time stochastic processes.
9	Least-squares estimation.
10	Bayes estimation.
11	Solution of the prediction problem.
12	Identification of discrete-time stochastic models from observed data.
13	State estimation from observed data.

References

References on dynamic systems analysis:

P. J. Antsaklis and A. N. Michel.
Linear Systems.
Birkhäuser, 2006.

G. Calafiore.
Elementi di Automatica.
CLUT, Torino, 2007.
(in Italian).

G. Marro.
Teoria dei Sistemi e del Controllo.
Zanichelli, 1989.
(in Italian).

S. Rinaldi.
Teoria dei Sistemi.
CLUP, Milano, 1977.
(in Italian).

References (cont.)

References on data-based estimation and identification:

T. Söderström. P. Stoica.
System Identification.
Prentice Hall, 1989.

L. Ljung.
System Identification – Theory for the User.
Prentice Hall, 1999.

S. Bittanti.
Teoria della predizione e del filtraggio.
Pitagora Editrice, Bologna, 2000.
(in Italian).

S. Bittanti.
Identificazione dei Modelli e Controllo Adattativo.
Pitagora Editrice, Bologna, 1997.
(in Italian).

S. Bittanti, M. Campi.
Raccolta di Problemi di Identificazione, Filtraggio, Controllo Predittivo.
Pitagora Editrice, Bologna, 1996.
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