COMPUTER ENGINEERING (LM55)

(Lecce - Università degli Studi)

Teaching ESTIMATION AND DATA ANALYSIS WITH APPLICATIONS

GenCod A004569

Owner professor GIANFRANCO PARLANGELI

Teaching in italian ESTIMATION AND DATA ANALYSIS WITH APPLICATIONS

Teaching ESTIMATION AND DATA ANALYSIS WITH APPLICATIONS

SSD code ING-INF/04

Reference course COMPUTER ENGINEERING

Course type Laurea Magistrale

Credits 9.0

Teaching hours Front activity hours: 81.0

For enrolled in 2017/2018

Taught in 2018/2019

Course year 2

Language ENGLISH

Curriculum PERCORSO COMUNE

Location Lecce

Semester Second Semester

Exam type Oral

Assessment Final grade

Course timetable https://easyroom.unisalento.it/Orario

BRIEF COURSE DESCRIPTION

This course offers a broad overview of fundamental and emerging topics in the area of estimation theory and data analysis; furthermore, a set of applications are illustrated in the fields of robotics, multi-agent and cyber-physical systems, social systems and electric networks. It is aimed at providing principles and tools to state and solve estimation problems in technological systems, and the solution is numerically sought with the aid of a suitable software (Mathworks Matlab is used in the course).

REQUIREMENTS

Sufficiency in calculus, probability theory, linear algebra.

COURSE AIMS

Learning Outcomes; after the course the student should be able to:
(**Conoscenze e comprensione**) Describe and explain the main peculiarities (both advantages and disadvantages) of each mathematical framework for the estimation problems considered in the course.
(**Capacità di applicare conoscenze e comprensione**)+ (**Abilità comunicative) + (Autonomia di giudizio)** Be aware of, describe and explain practical problems of bad data gathering and robustness issues in the framework of estimation theory.
(**Capacità di applicare conoscenze e comprensione**)+ (**Capacità di apprendimento)** For a given practical problem at hand, be able to state an estimation problem in a natural mathematical setting, either stochastic or deterministic, based on the problem assumptions.
(**Capacità di applicare conoscenze e comprensione**) +(**Abilità comunicative) + (Autonomia di giudizio)** Build a simulation framework to find a computer-aided solution of the stated mathematical problem with the use of a suitable software.
(**Abilità comunicative)+(Capacità di apprendimento)** Willing students may hold a seminar on an application of interest where to apply the methodologies developed along the course.

TEACHING METHODOLOGY

Lezioni frontali svolte in aula dal docente tramite l'ausilio di gesso e lavagna. Nel corso delle lezioni saranno occasionalmente illustrati e discussi software commerciali.

ASSESSMENT TYPE	The exam is an oral discussion (including possibly one written exercise) and it is aimed to determine to what extent the student has: 1) the ability to identify and use data to formulate responses to well-defined problems, 2) problem solving abilities to seek a solution through an algorithm. Additionally, willing students may have a seminar on an application of interest where the methodologies of the course are applied.
FULL SYLLABUS	Introduction. Mathematical background and connections with other courses (2 hours). Stochastic Estimators: definitions, properties, performances and fundamental limitations. Foundations of maximum likelihood estimation (10 hours). The Bayesian approach to the estimation problem (7 hours). Kalman filter: discrete-time stochastic state models, (two-steps) structure, computation of the optimal gain, the alternative geometric approach. Steady–state behavior. Extended Kalman Filter (16 hours). Applications of Kalman Filter (6 hours). Set membership estimation: introduction, fundamental results and theorems (8 hours). Set membership estimation: some applications (4 hours). Robust estimation: introduction, fundamental definitions, estimator classes and performances (7 hours). Data driven by unknown external entities: vulnerability analysis, resilient estimator design (6 hours). Applications of the previous issues and results to various fields (3 hours). Data analysis: mathematical tools, foundations. Elements of clustering and classification (7 hours). The electric power system state estimation. Overview of Electric Power System State Estimation techniques. (5 hours).
REFERENCE TEXT BOOKS	[1] Ljung, Lennart. "System Identication: Theory for the user" Englewood Cliffs, 1987. [2] Anderson, Brian DO, and John B. Moore. "Optimal Filtering" (1979). [3] Milanese, M., Norton, J., Piet-Lahanier, H., & Walter, É. (Eds.). (2013). Bounding approaches to system identification. Springer Science & Business Media. [4] Zaki, Mohammed J., and Wagner Meira Jr. "Data mining and analysis: fundamental concepts and algorithms", Cambridge University Press, 2014.