COMMUNICATION ENGINEERING AND ELECTRONIC TECHNOLOGIES

(Lecce - Università degli Studi)

Teaching STATISTICAL SIGNAL PROCESSING

GenCod A002613

Owner professor Giuseppe RICCI

Teaching in italian STATISTICAL SIGNAL PROCESSING

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SSD code ING-INF/03

Reference course COMMUNICATION ENGINEERING AND ELECTRONIC

Course type Laurea Magistrale

Credits 9.0

Teaching hours Front activity hours: 81.0

For enrolled in 2017/2018

Taught in 2017/2018

Course year 1

Language ENGLISH

Curriculum PERCORSO COMUNE

Location Lecce

Semester First Semester

Exam type Oral

Assessment Final grade

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

BRIEF COURSE DESCRIPTION

Course Content.

Introduction: examples of statistical reasoning (2 hours).

Rudiments of Multivariate Normal Theory (9 hours). Solution to assigned problems (6 hours).

Estimation Theory: Classical vs Bayesian Parameter Estimators. How to measure the performance of an estimator. Cramer-Rao bounds. Estimation of non random parameters (22 hours). Solution to assigned problems (12 hours).

Estimation of random parameters: MMSE estimation, linear MMSE estimation. Discrete-Time Kalman Filter. Extended Kalman Filter. Applications of Kalman Filter to tracking (9 hours). Solution to assigned problems (4 hours).

Applications to communication theory (8 hours).

Detection Theory: Neyman-Pearson Lemma, Testing of composite binary hypotheses, UMP tests, Constant False Alarm Rate property; Bayes detectors (4 hours). Solution to assigned problems (5 hours).

REQUIREMENTS

Prerequisites: sufficiency in calculus, probability theory, linear algebra, and digital communication theory.

COURSE AIMS

Overview.

This is a course in estimation and detection theory; it is aimed at providing principles and tools to solve problems in signal processing, radar, sonar, and communication. It will also serve as the necessary prerequisite for more advanced courses in communication engineering.

Learning Outcomes.

After the course the student should be able to

*Describe classical and Bayesian approaches to estimation; illustrate the main strategies to solve binary hypotheses tests (Neyman-Pearson, GLRT).

*Formulate and solve parameter estimation problems and derive corresponding Cramer-Rao lower bounds. Formulate and solve detection problems resorting to the optimum (i.e., Neyman-Pearson test or UMP test) if possible or to a suboptimum one (GLRT). Evaluate the performance parameters and discuss complexity issues associated with different solutions.

*Derive the Kalman filter and the extended Kalman filter from first principles and use them to solve simplified tracking problems.

*Illustrate synchronization techniques of digital receivers (phase recovery circuits and frequency recovery circuits) starting from first principles (estimation theory).

ASSESSMENT TYPE

Examination.

Written exam. The exam consists of two cascaded parts (maximum overall duration: two hours and a half):

the first part is closed book (suggested duration 50 minutes); the student is asked to illustrate two theoretical topics; it is aimed to verify to what extent the student has gained knowledge and understanding of the selected topics of the course and is able to communicate about his/her understanding (the maximum score for illustrating each topic is typically 5/30);

the second part, that starts when the student has completed the first part, is open book and requires solving two (or three) problems; 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 and the capacity to integrate different concepts and tools (the maximum score for the solution of each problem is typically 10/30 or 6-7/30 if the second part of the exam requires solving three problems).

OTHER USEFUL INFORMATION

Office Hours: by appointment; contact the instructor by email or at the end of class meetings.

FULL SYLLABUS

Statistical Signal Processing - Master degree (LM) in Communication Engineering and Electronic Technologies (Fall semester)

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References.

[1] Handouts (in progress).

[2] L. L. Scharf, ``Statistical Signal Processing: Detection, Estimation, and Time Series Analysis,'' Addison-Wesley, 1991.

[3] H. L. Van trees, ``Detection, Estimation and Modulation Theory,'' Part. 1 and 4, John Wiley & Sons.
[4] S. M. Kay: ``Fundamentals of Statistical Signal Processing: Estimation Theory,'' Volume I, Prentice-Hall, 1993.
[5] S. M. Kay: ``Fundamentals of Statistical Signal Processing: Detection Theory,'' Volume II, Prentice-Hall, 1998.
[6] Y. Bar-Shalom, T. E. Fortmann, ``Tracking and Data Association, Academic Press'', 1988.
[7] U. Mengali, A. N. D'Andrea: ``Synchronization Techniques for Digital Receivers,'' Plenum Press, 1997.

REFERENCE TEXT BOOKS

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