UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2022/2023
MASTER'S DEGREE (MSC)	ELECTRONICS AND TELECOMMUNICATIONS ENGINEERING (FULLY ONLINE)
SUBJECT	DATA ANALYSIS
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	20925-Attività formative affini o integrative
CODE	21738
SCIENTIFIC SECTOR(S)	ING-INF/04
HEAD PROFESSOR(S)	SFERLAZZA ANTONINO Ricercatore a tempo determinato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	108
COURSE ACTIVITY (Hrs)	42
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**SFERLAZZA ANTONINO** Monday 15:00 17:00 Ufficio del Docente o su M. Teams (4r406w2) Thursday 11:00 13:00 Ufficio del Docente o su M. Teams (4r406w2)

DOCENTE: Prof. ANTONINO SFERLAZZA

PREREQUISITES	Basics of Automatic Controls, Signal Analysis, probability theory and Linear Algebra are recommended.
LEARNING OUTCOMES	Knowledge and understanding: At the end of the course, the student will have knowledge of stochastic processes and random variables, first and second order moments, Estimation Algorithms, BLUE, MINIMUM VARIANCE, GAUSS-Markov, Maximum likelihood estimation, Minimum Squares method. Optimal filtering and estimation of systems that can be modeled through stochastic processes. Applied knowledge and understanding: Given a stochastic system, the student will be able to design an optimal filter for estimation and/or prediction of stochastic processes. Given a dynamic system with a known model, but with unknown parameters, the student will be able to design an identification experiment that allows to estimate the unknown parameters of the model. Moreover, he will be able to choose the appropriate input-output variables in an identification experiment. Judgements: The student should be able to generalize the techniques and concepts acquired during the course and to establish the relationships with other subjects. Communication skills: The student will learn the ability to rationally communicate her/his knowledge about the concepts and methods of the discipline, with a good level of clearness, fluency and correct use of technical language. To achieve this goal, the student can rely on the video lectures and on the interactions with the tutor. Learning skills: The course aims to stimulate the student's interest in a rigorous approach to deal with of the various topics covered by the course. The student who acquires this study methodology will certainly be able to continue his engineering studies with greater autonomy and with greater profit.
ASSESSMENT METHODS	EXAM ORGANIZATION The examination is based on a written test and on the evaluation of the student homework. The grade of the written test is given in the range 0-25, while the grade of the homework in the range 0-5. The final grade is given by the sum of the written test and homework evaluation. The minimum grade to pass the test is 18/30. DESCRIPTION OF THE TESTS The written test is divided in two parts: the first part includes two exercises similar with that ones proposed at the end of each teaching module; the second part includes open and semi-structured questions about all the course contents. The written test lasts 1.5 hours. The homework is based on the autonomous elaboration of an advanced/ research topic (typically about estimation techniques and optimal filtering) selected by the student, which is organized in a power-point presentation. The homework allows to assess: - The capability of reading and understanding the research literature and the technology standards related to the course topics; - The ability of reinterpretation of the concepts and interdisciplinary connections, showing evidence for autonomously undertaking further studies or professional activity. LEARNING OUTCOMES In order to provide the overall evaluation, we will estimate the results achieved in the following course objectives. Knowledge and understanding: Evaluation of knowledge, understanding and integration of principles, concepts, methods and techniques of the discipline. Applying knowledge: Evaluation of capabilities in applying theoretical and technical knowledge for tackling and solving problems; evaluation of the autonomy level and originality of proposed solutions. Making judgements: Evaluation of logical, analytical and critical abilities for reaching appropriate judgments and decisions, based on available information and data. Communication skills and learning skills: Evaluation of the ability to communicate knowledge, analysis and conclusions, with a good level of clearness, fluency and correct use of language. GRADES 30-30 and laude: Excellent. Full knowledge and understanding of concepts and methods of the discipline, excellent analytical skills even in solving original problems; excellent communication and learning skills.

	27-29: Very good. Very good knowledge and understanding of concepts and methods of the discipline; very good communication skills; very good capability of concepts and methods applications. 24-26: Good. Good knowledge of main concepts and methods of the discipline; discrete communication skills; limited autonomy for applying concepts and methods for solving original problems. 21-23: Satisfying. Partial knowledge of main concepts and methods of the discipline; satisfying communication skills; scarce judgment autonomy. 18-20: Acceptable: Minimal knowledge of concepts and methods of the discipline; minimal communication skills; very poor or null judgement autonomy. Non acceptable: Insufficient knowledge and understanding of concepts and methods of the discipline.
EDUCATIONAL OBJECTIVES	The aims of the course are the following: 1) To introduce the stochastic processes, to evaluate their properties, and to introduce the linear models of stochastic processes. 2) To give basics of estimation theory, using both parametric and Bayesian approaches; 3) To learn optimal filtering techniques for stochastic systems;
TEACHING METHODS	The course is organized in 3 modules, each one including a set of video lectures (pre-recorded) and a set of e-tivity: More into details, the list of modules is the following one: 1) Stochastic processes (7 hours of video lectures); 2) Estimation theory (7 hours of video lectures); 3) Optimal filtering (7 hours of video lectures). For each module, we propose a set of exercises as additional learning activities, also devised to facilitate the self-assessment of the learning outcomes. We expect that each student will dedicate about 21 hours for these activities. About one half of the activities are proposed as activities to be carried out autonomously by the students, while another half will be supervised or led by the course tutor. More into details, the interactive activities planned for each module are the following one: 1)Laboratory on the usage of MATLAB for computation and simulation of linear models of stochastic processes (3 hours with tutor); exercises (4 hours); 2)Laboratory on the usage of MATLAB for implementation of estimation algorithm (3 hours); exercises (4 hours); 3)Laboratory on the usage of MATLAB for implementation of IIR and FIR Wiener's filters (3 hours); exercises (4 hours); The activities will be organized on the on-line learning platform, also exploiting discussion forums and interactive meetings for the organization of the laboratorial activities. The overall number of hours for the individual study activities is estimated equal to additional about 90 hours, which include 21 hours for replaying the video lectures.
SUGGESTED BIBLIOGRAPHY	- F. L. Lewis, Optimal Estimation, John Wiley & Sons, 1986 - ISBN-10: 0471837415. - E. W. Kamen and J. K. Su, Introduction to Optimal Estimation, Springer, 1999 - ISBN: 978-1-4471-0417-9. - T. Soderstrom, Discrete-time Stochastic Systems, Springer, 2002 - ISBN: 978-1-4471-0101-7. - L. Ljung, Identification: Theory for the User, Prentice-Hall, 1999 - ISBN-10: 0136566952. - Lectures slides.

SYLLABUS

Hrs	Frontal teaching
2	Stochastic processes: definitions and properties, examples of stochastic processes (MODULE 1)
2	Frequency analysis (MODULE 1)
3	Linear models of stochastic processes (MODULE 1)
1	Introduction to estimation theory (MODULE 2)
3	Parametric estimation, least squares estimator and Gauss-Markov estimator (MODULE 2)
1	Maximum likelihood estimate (MODULE 2)
2	Bayesian estimate and minimum mean square error estimate (MODULE 2)
3	Optimal filtering, Wiener FIR filter, Wiener FIR predictor (MODULE 3)
4	Spectral factorization and Wiener IIR predictor (MODULE 3)

Hrs	Practice
4	Exercises about stochastic processes (E-TIVITY, MODULE 1)
4	Exercises about estimation theory (E-TIVITY, MODULE 2)
4	Exercises about optimal filtering (E-TIVITY, MODULE 3)

Hrs	Workshops
3	Computation and simulation of linear models of stochastic processes with MATLAB (E-TIVITY, MODULE 1)
3	Design of an estimation algorithm using MATLAB (E-TIVITY, MODULE 2)
3	Implementation of IIR and FIR Wiener’s filters using MATLAB (E-TIVITY, MODULE 3)