Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și
Tehnologia Informației

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Applied Electronics and Information Engineering**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Electric Vehicle Propulsion and Control

2. Date despre disciplină

2.1 Course name (ro) (en)				Prelucrarea statistică a semnalelor și teoria estimării Statistical Signal Processing and Estimation Theory			
2.2 Course Lecturer				Conf. Dr. Anamaria RĂDOI			
2.3 Instructor for practical activities				Conf. Dr. Anamaria RĂDOI			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M1.O.24-02		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	2	Out of which: 3.2 course	1.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	28.00	Out of which: 3.5 course	14	3.6 seminary/laboratory	14
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					64
Tutoring					0
Examinations					8
Other activities (if any):					0

3.7 Total hours of individual study	72.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Completion of the following subjects: • Probability theory and statistics • Information transmission theory • Decision and estimation in information processing • Digital signal processing
4.2 Results of learning	Obtain: • Notions of statistical signal processing • Notions of random process analysis • Notions of decision theory • Notions of parameter estimation

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	The course will take place in a room equipped with video-projector and computer.
5.2 Seminary/ Laboratory/Project	The application sessions will take place in a room with adequate equipment (blackboard) and must include a video-projector.

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

This subject is studied within the field of Electronic Engineering, Telecommunications and Information Technologies / Master program Electrical Vehicle Propulsion and Control (EPIC) and aims to familiarize students with the main approaches, models and explanatory theories of the field, used in solving practical applications and problems that specifically respond to the current development requirements, subscribed to the European economy.
The discipline addresses as a specific topic, basic notions (probability & statistics, random signal processing techniques, decision, parameter estimation), as well as advanced ones (classification), concepts and principles specific to the domain. The concepts in the course syllabus have practical applications in various fields, such as artificial intelligence, data mining, pattern recognition, signal / image processing, data compression, industrial automation, robotics (human-machine interfaces), security (security systems and biometric systems), and, last but not least, the Automotive field, which is the target of this master's program. The discipline thus contributes to the formation of an overview of the field, providing graduates with the necessary skills, as well as a scientific and technical training adequate to the current requirements at an international level.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	Understanding and usage of fundamental concepts for statistical signal processing Combines knowledge Applies the gained knowledge in practice Applies methods and standard domain-specific instruments for identifying problems and optimal solutions Correctly analyses the application context of basic domain knowledge by using key concepts in terms of subject and specific methodology Oral and writtem communication in English: demonstrate understanding of the vocabulary related to the field, in a foreign language.

Transversal (General) Competences	The ability to make decisions in order to solve current problems that arise when performing statistical signal analysis The ability to constantly inform and document for personal and professional development by reading specialized literature The ability to analyze and synthesize information Autonomy and critical thinking Flexibility in using new systems and technologies within a team where members together achieve a well-defined goal while taking on different roles or tasks Compliance with the principles of academic ethics The ability to work in stressful situations and optimal time management.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* • Defines domain-specific notions such as probability density function, mean, variance, correlation, covariance, correlation coefficient, regression, autocorrelation function, power spectral density, stationarity, ergodicity, optimal filtering. • Describe/classify decision and estimation systems. • Highlights consequences of using certain estimation techniques. • Knows decision criteria and parameter estimation techniques.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* • Select relevant information for designing decision systems and parameter estimation techniques. • Work in a team through discussions related to solving some requirements during the exercise sessions. • Solve applications during the exercise sessions. • Analyze and compare various decision and estimation methods.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Select appropriate bibliographic sources. • Respect the principles of academic ethics. • Demonstrate adaptability to learning in new contexts. • Collaborate with other colleagues and teaching staff during the performance of teaching activities. • Demonstrate autonomy in problem solving. • Demonstrate social responsibility through active involvement in events in the academic community. • Realize the value of his contribution in the field of engineering to the identification of solutions to real problems of a social and economic nature, demonstrating social responsibility. • Apply principles of professional ethics/deontology in identifying optimal solutions. •Demonstrate effective time management skills.

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

The teaching process will explore both expository (lecture, exposition) and conversational-interactive teaching methods, based on discovery learning models facilitated by direct and indirect exploration of reality, but also on action-based methods, such as exercise, activities practice and problem solving. The oral communication methods are exposition, problematization and conversation.
Lectures will be used in the teaching activity, based on presentations in .pdf format and notes written on the blackboard. Each course will start with a short review of the chapters already covered, with an emphasis on the concepts covered in the last course.
The presentations use images / diagrams and connections with current technology so that the information presented is easy to understand, assimilate and apply in various contexts. Active listening and assertive communication techniques will be applied, as well as bi-directional feedback mechanisms.
Teamwork skills will be practiced to solve different learning tasks in seminars and laboratories.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Elements of probability theory - Random variables - Stochastic processes - Empiric statistics	2
2	Random signals - Order 1 and order 2 characterization of random signals - Stationarity - Inter-correlation and inter-covariance - Power spectral density - Wiener-Hincin theorem - White noise	4
3	Linear filtering of random signals - AR, MA, ARMA models - Interpretation of filtering - Yule-Walker equations	3
4	Estimation of system parameters	4
5	Adaptive signal processing - Modeling an optimal Least-Squares filter - Adaptive filtering.	1
	Total:	14

Bibliography:
1. Anamaria Radoi, curs Statistical Signal Processing and Estimation Theory, https://curs.upb.ro/2021/course/view.php?id=9886
2. T. Hastie, R. Tibshirani, J. Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition, Springer, 2016
3. R. Gray, L. D. Davisson, An Introduction to Statistical Signal Processing, Cambridge University Press, 2012 (online version)
4. G. James, D. Witten, T. Hastie, R. Tibshirani, An Introduction to Statistical Learning, Springer-Verlag, 2013
5. C. Bishop, Pattern Recognition and Machine Learning, Springer-Verlag, 2006
6. C. Vertan, I. Gavat, R. Stoian, Variabile și procese aleatoare: principii și aplicații, Ed. Printech, 1999
7. A. Papoulis, S. U. Pillai, Proability, Random Variables, and Stochastic Processes, Mc Graw Hill, 2000

SEMINARY

Crt. no.	Content	No. hours
1	Random variables. Classical discrete and continuous repartitions.	2
2	Pairs of random variables. Transformations of random variables. Marginal densities. Correlation. Covariance.	2
3	Correlation coeficient. Regression.	2
4	Random processes. Power spectral density. Wiener-Hincin theorem. Random signals through time-invariant linear systems.	2
5	Discrete random signals. Yule-Walker equations. AR, MA, ARMA models. Prediction.	2
6	Parameter estimation.	2
7	Adaptive filtering	2
	Total:	14

Bibliography:
1. Anamaria Radoi, curs Statistical Signal Processing and Estimation Theory, https://curs.upb.ro/2021/course/view.php?id=9886
2. T. Hastie, R. Tibshirani, J. Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition, Springer, 2016
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11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade

11.4 Course	Rigorous knowledge of basic theoretical concepts (probabilities, probability density function, distribution function, mean, dispersion, correlation, covariance, autocorrelation function, power spectral density, white noise, random signal filtering, mean cost, quadratic estimate, estimated MAP, estimated MLE, principal component analysis, quantization) and methods to operate with these notions.	Final written exam (during Exam session)	40%
11.5 Seminary/laboratory/project	Test paper	Grading during the semester	30%
	Mini-project	Grading during the semester	30%
11.6 Passing conditions			
• Obtaining 50% of the total score.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

• Through the activities carried out, students develop skills to offer solutions to problems and to propose ideas for improving the existing situation in the field of Electronics, including in the field of Artificial Intelligence by expanding some notions and concepts.
• The course has a similar content to the courses held by Stanford University.

Date	Course lecturer	Instructor(s) for practical activities
11.10.2024	Conf. Dr. Anamaria RĂDOI	Conf. Dr. Anamaria RĂDOI

Date of department approval — Head of department

Conf. dr. ing. Bogdan Cristian FLOREA

Date of approval in the Faculty Council — Dean

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Prof. Dr. Mihnea Udrea