Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

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	Bachelor/Undergraduate
1.6 Programme of studies	Applied Electronics

2. Date despre disciplină

2.1 Course name (ro) (en)				Decizie şi estimare în prelucrarea informaţiilor Decision and estimation in information processing			
2.2 Course Lecturer				Prof. Dr. Ing. Anamaria RĂDOI			
2.3 Instructor for practical activities				Prof. Dr. Ing. Anamaria RĂDOI			
2.4 Year of studies	3	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		D	2.9 Course code	04.D.06.O.007		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	5	Out of which: 3.2 course	3	3.3 seminary/laboratory	2
3.4 Total hours in the curricula	70	Out of which: 3.5 course	42	3.6 seminary/laboratory	28
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.					26
Tutoring					0
Examinations					4
Other activities (if any):					0

3.7 Total hours of individual study	30.00
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: Mathematical analysis 1 Linear algebra, analytic and differential geometry Probability theory and mathematical statistics Signals and systems Programming Languages 1,2

4.2 Results of learning	Notions of probabilities Random variables Random signals Linear systems Parameter estimation Quantization Decision

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 a blackboard, video projector and computer
5.2 Seminary/ Laboratory/Project	The laboratory will take place in a room with computers

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 discipline is studied within the field of Electronic Engineering, Telecommunications and Information Technologies / specialization Applied Electronics and aims to familiarize students with the main approaches, models and explanatory theories of the field, used in solving practical applications and problems that concretely respond to current technological developments, subscribed to the European economy.

The discipline addresses as a specific topic the following 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 DEPI 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 biometrics), etc. 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 using fundamental concepts in the field of communications and information transmission
Transversal (General) Competences	The ability to take decisions in order to solve current or unpredictable problems that arise in the process of operating the computer system Ability to ensure planning and management of information engineering projects The ability to constantly inform and document for personal and professional development by reading specialized literature The ability to communicate and present technical content in both Romanian and English Flexibility in using new systems and technologies within a team where members together achieve a well-defined goal while assuming different roles or tasks.

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. Describes/classifies 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).* Selects relevant information for designing decision systems and parameter estimation techniques. Works as a team through discussions related to solving some requirements within the laboratory. Experimentally verifies solutions identified through tests on Moodle (VPL environment). Solves both seminar and laboratory applications. Analyzes and compares various decision and estimation methods. Formulates conclusions to the experiments carried out.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Selects appropriate bibliographic sources. Respects the principles of academic ethics. Demonstrates receptivity to learning in new contexts. Demonstrates collaboration with other colleagues and teaching staff during the performance of teaching activities. Demonstrates autonomy in problem solving. Demonstrates social responsibility through active involvement in academic community events. Realizes 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. Applies principles of professional ethics/deontology in identifying optimal solutions. Demonstrates 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 used are exposition, problematization and conversation.

Lectures will be used in the teaching activity, based on presentations in .pdf format and notes written on the board. Each course will start with a recap 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	Introduction to probability theory. Random variables. Random vectors. Classic distributions. Pairs of random variables. Statistical moments. Transformations of random variables.	7
2	Regression	3
3	Random signals. Statistical means. Temporal environments. Stationarity. Ergodicity.	4
4	Power spectral density. The Wiener-Hincin theorem. White noise. Passage of random signals through time-invariant linear systems. Filter adapted to the shape of the signal.	6
5	Discrete-time random signals. The autocorrelation matrix. The linear models AR, MA, ARMA. The Yule-Walker equations. Optimal filtering of discrete random processes. The principle of orthogonality.	6
6	Decision systems. Bayes decision criterion for binary decision. Decision on classification issues.	4
7	Parameter estimation. Minimizing average cost. The quadratic estimate. The maximum a-posterior estimate. The maximum plausibility estimate. Assessing the quality of an estimator.	4
8	Principal component analysis. Applications.	3
9	Quantization of random signals. Uniform quantization. The Lloyd-Max optimal quantizer. Vector quantization.	3
10	EM algorithm.	2
	Total:	42

Bibliography:
1. Rădoi Anamaria, Decizie şi estimare în prelucrarea informaţiilor, https://curs.upb.ro/2021/course/view.php?id=9019
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. M. Ciuc, C. Vertan, Prelucrarea statistică a semnalelor, Ed. MatrixRom, 2005
7. A. Papoulis, S. U. Pillai, Proability, Random Variables, and Stochastic Processes, Mc Graw Hill, 2002
8. V. Neagoe, O. Stănăşilă, Teoria recunoaşterii formelor, Ed. Academiei Române, 1992
9. A. Spătaru, Fondements de la Theorie de la Transmission de l'Information, Presses Polytechnique Romandes, 1987

LABORATORY

Crt. no.	Content	No. hours
1	Introduction to Python.	2
2	Random variables. Random vectors. Discrete distributions.	2
3	Pairs of random variables. Correlation. Covariance. Linear regression.	2
4	Random signals. Power spectral density. Periodogram. Passing a random signal through linear time-invariant systems.	2
5	Decision systems. Bayes criteria. Classification.	2
6	Parameter estimation.	2
7	Principal component analysis.	2
	Total:	14

SEMINARY

Crt. no.	Content	No. hours
1	Random variables. Discrete and continuous distributions.	2
2	Pairs of random variables. Transforming random variables. Marginal probability density functions. Correlation. Covariance. Correlation coefficient. Regression.	2
3	Random process. Power spectral density. Wiener-Hincin theorem. Passing a random signal through linear time-invariant systems.	2
4	Discrete random signals. Yule-Walker equations. AR, MA, ARMA models. Prediction.	2
5	Decision systems. Classification using Bayes criteria.	2
6	Parameter estimation.	2
7	Quantization of random signals.	2
	Total:	14

Bibliography:
1. Rădoi Anamaria, Decizie şi estimare în prelucrarea informaţiilor, https://curs.upb.ro/2021/course/view.php?id=9019
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 şi procese aleatoare: principii şi aplicaţii, Ed. Printech, 1999
7. A. Papoulis, S. U. Pillai, Proability, Random Variables, and Stochastic Processes, Mc Graw Hill, 2000

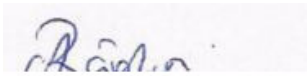
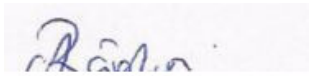
11. Evaluation

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) and methods to operate with these notions.	Verification work during the semester	20%
	Rigorous knowledge of basic theoretical notions (discrete time random signals, Bayes decision criterion, average cost, quadratic estimation, MAP estimation, MLE estimation, principal component analysis, quantization) and methods to operate with these notions.	Final exam (written) during exam session	30%
11.5 Seminary/laboratory/project	Solving the exercises during the semester	Tests	25%
	Understanding the experiments performed in the laboratory and solving the homework during the semester	Grading during laboratory hours	10%
	The correct interpretation of the results of the experiments through the theoretical elements taught in the course.	Laboratory verification	15%
11.6 Passing conditions			
Obtaining 50% of the total score. Obtaining 50% of the lab 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 Applied Electronics, including in the field of Artificial Intelligence by expanding some notions and concepts.

The course has a similar content to the courses held at Stanford University.

Date	Course lecturer	Instructor(s) for practical activities
25.09.2025	Prof. Dr. Ing. Anamaria RĂDOI 	Prof. Dr. Ing. Anamaria RĂDOI 

Date of department approval	Head of department Conf. Dr. Bogdan Cristian Florea

Date of approval in the Faculty Council	Dean Prof. Dr. Mihnea Udrea