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	**Electronic Devices, Circuits and Architectures**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Microelectronics, Optoelectronics and Nanotechnologies

2. Date despre disciplină

2.1 Course name (ro) (en)				Teoria probabilităţilor şi statistică matematică Probability theory and mathematical statistics			
2.2 Course Lecturer				Simion Emil			
2.3 Instructor for practical activities				Tănase Roxana			
2.4 Year of studies	2	2.5 Semester	2	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		F	2.9 Course code	04.F.04.O.019		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3	Out of which: 3.2 course	2	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42	Out of which: 3.5 course	28	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.					30
Tutoring					0
Examinations					3
Other activities (if any):					0

3.7 Total hours of individual study	33.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Knowledge of mathematical analysis and algebra, according to the high-school baccalaureate syllabus and the faculty admission syllabus. The courses “Mathematical Analysis”, “Linear Algebra, Analytic and Differential Geometry”, and “Special Mathematics”.
4.2 Results of learning	-

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

5.1 Course	Lecture hall for approx. 150 seats, equipped with a board and video projector.
5.2 Seminary/ Laboratory/Project	Seminar room for approx. 30 seats, equipped with a board.

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)*

The study of probability theory and mathematical statistics is essential for a wide range of scientific and applied fields, offering students fundamental knowledge and useful skills for understanding and managing uncertainty and variability. Mathematical statistics provides tools for collecting, organizing, and interpreting data. This is vital in the era of big data, where the ability to extract relevant information from large volumes of data is a major advantage. Statistical methods enable data analysis to make evidence-based decisions, whether in business, public health, policy, or scientific research. By correctly interpreting data, errors in judgment and incorrect conclusions can be avoided. In many academic domains, probability and statistics are essential for designing and interpreting experiments, testing hypotheses, and evaluating the validity of results. Probability and statistics also play a central role in artificial intelligence and machine learning, where probabilistic models are used to make predictions, learn from data, and model complex behaviors. Probability theory and mathematical statistics are fundamental disciplines that provide theoretical and practical tools to understand and analyze random phenomena and to make informed decisions under uncertainty. This knowledge is crucial across diverse fields and contributes significantly to students' personal and professional success.

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 fundamental concepts in probability theory and mathematical statistics, with an emphasis on their applicability in electronic engineering. • Ability to model random phenomena and interpret results in specific technical contexts (signals, noise, reliability, communications, etc.). • Applying statistical methods for the analysis and interpretation of experimental and technological data. • Using probability distributions, statistical tests, parameter estimation, and regression techniques to solve engineering problems. • Developing the ability to make decisions based on uncertain data by assessing risks and variability in engineering processes. • Cultivating critical and analytical thinking in data processing and in evaluating statistical models.

Transversal (General) Competences	• Mastering optimal learning methods, combining theoretical results, and practicing teamwork. • Learning how to defend an idea and conduct a scientific debate. • Honorable, responsible, ethical conduct, in the spirit of the law, to ensure the profession's reputation. • Awareness of the need for lifelong learning; efficient use of learning resources and techniques for personal and professional development.

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.* • Explains domain-specific concepts. • Provides examples for the studied concepts. • Correlates the studied concepts intra- and interdisciplinarily. • Recognizes the studied concepts within processes in specialty disciplines. • Compares certain studied concepts, highlighting similarities and differences.
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 and groups relevant information in a given context. • Applies the studied theory in solving applications. • Uses specific results, with justification, to solve problems. • Combines various methods and arguments to solve problems. • Creates a scientific text. • Interprets a practical problem from a mathematical perspective. • Identifies multiple approaches to solve a problem, where applicable, and proposes solution plans. • Formulates conclusions following the application of the studied concepts. • Anticipates the steps/modes of solving.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Selects suitable bibliographic sources and analyzes them. • Respects the principles of academic ethics by correctly citing the bibliographic sources used. • Demonstrates receptiveness to new learning contexts. • Shows collaboration with colleagues and teaching staff in carrying out educational activities. • Demonstrates autonomy in organizing the learning context/situation or the problem situation to be solved. • Promotes/contributes with new solutions, within the specialty, to improve the quality of social life. • Analyzes and interprets business/entrepreneurial development opportunities in the specialty field. • Demonstrates management skills for real-life situations (time management, collaboration vs. conflict).

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.)*

Starting from the analysis of students' specific learning characteristics and needs, the teaching process will include both expository methods (such as lecture and presentation) and interactive, conversational methods, based on discovery learning models, with emphasis on direct and indirect exploration of reality (demonstration, modeling). Action-based methods will also be used, such as exercises and problem solving. Each course will begin with a recap of previously covered concepts. This discipline offers both theoretical information and practical activities intended to support students in the learning process and in developing effective collaboration and communication relationships, in a setting favorable to discovery-based learning. Emphasis will be placed on developing active listening and assertive communication skills, as well as feedback construction mechanisms, as means of behavioral regulation and adapting the pedagogical approach to students' needs.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Events, probability space. Events, sample space; absolute and relative frequency of occurrence of an event; field of events, complete system of events; operations with events; probability space; axiomatic definition of probability (Kolmogorov sense); properties of probability; probability of independent and conditional events; Law of Total Probability; Bayes' formula; Boole's inequality. Probability schemes. Bernoulli scheme (with two and more states), Poisson, hypergeometric	4

2	Discrete and continuous random variables. Definitions, probability mass function, probability density, distribution function; operations with simple discrete random variables; functions of random variables. Numerical characteristics of random variables. Mean, variance, standard deviation, raw and central moments, covariance, correlation coefficient, moment generating function, characteristic function. Classical distributions (classical probability laws, discrete and continuous). Bernoulli, binomial, Poisson, uniform (discrete and continuous), exponential, normal; Gauss–Laplace function; Applications.	6
3	Bivariate vectors (simple discrete random variables). Representation, probability function, distribution function; marginal and conditional distributions, marginal and conditional means. Bivariate vectors (continuous random variables). Probability density, distribution function; marginal and conditional densities and distribution functions; marginal and conditional means. Operations with continuous random variables (transformations of random variables, distribution of the sum, difference, product, and quotient). Regression. Regression functions, linear and nonlinear estimations	6
4	Sequences of random variables, Law of Large Numbers, Central Limit Theorem. Types of convergence, Chebyshev's inequality, the "3-sigma" rule, LLN (weak form), LLN in Bernoulli form; CLT in Lyapunov form, in Moivre–Laplace form. Applications. Stochastic processes. Markov property. The notion of a stochastic process, the Markov property. Applications and examples (Poisson processes, birth–death processes, reliability, etc.)	4
5	Elements of descriptive statistics. Data sets, data grouping (data classes), indicators of central tendency, dispersion, and position; graphical representation of data; Inferential statistics. Point estimation. Statistical population, samples, statistics, types of estimators; Applications of point estimators: Method of moments, Maximum likelihood method. Interval estimation using confidence intervals. Concept of quantile, significance level, confidence interval. Determining confidence intervals for the parameters of common distributions (normal, exponential, Bernoulli, Poisson). Statistical hypotheses. Parametric and nonparametric tests. Tests for verifying hypotheses regarding the parameters of the normal distribution, z-test for proportions; graphical tests, chi-square goodness-of-fit test, Smirnov–Kolmogorov goodness-of-fit test.	8
	Total:	28

Bibliography:

1. Pagina cursului de pe platforma https://curs.upb.ro/.
2. Gheorghe Budianu, Probabilităţi şi statistică, Editura Fair Partners, 2005.
3. Mariana Craiu, Statistică matematică. Teorie şi probleme, Editura Matrix Rom, 1998.
4. Morris H. DeGroot, Mark J. Schervish, Probability and Statistics, Fourth Edition, Pearson, 2011.
5. Irina Meghea, Matematici speciale, Editura Politehnica Press, 2011.
6. Andrei G. Oprina, Emil Simion, Elemente de teoria probabilităţilor, Editura Matrix Rom, 2017.
7. Raluca Purnichescu-Purtan, Probabilităţi şi statistică. Teorie, exerciţii, aplicaţii în MATLAB, Editura Printech, Bucureşti, 2015.
8. Liviu Jalbă, Octavian Stănăşilă, Sfera incertitudinii. Statistică aplicată, Fundaţia Floarea Darurilor, Bucureşti, 2017.
9. https://www.probabilitycourse.com/

SEMINARY

Crt. no.	Content	No. hours
1	Events, probabilities (properties, examples). Conditional probabilities (multiplication rule, law of total probability, Bayes' formula)	1
2	Probability schemes	1
3	Random variables (discrete) (mean, variance, covariance, correlation coefficient)	2
4	Distribution functions, probability density; continuous distributions	1
5	Bivariate random vectors	2
6	Operations with continuous random variables. Linear and nonlinear estimations	2
7	Sequences of random variables, Chebyshev's inequality, law of large numbers, central limit theorem	1
8	Stochastic processes	1
9	Descriptive and inferential statistics, point estimations	1
10	Confidence intervals. Verification of statistical hypotheses, statistical tests	2
	Total:	14

Bibliography:

1. Pagina cursului de pe platforma https://curs.upb.ro/.
2. Gheorghe Budianu, Probabilităţi şi statistică, Editura Fair Partners, 2005.
3. Gheorghe Budianu, Cristina Şerbănescu, Probleme de probabilităţi şi statistică, Editura Fair Partners, 2005.
4. Mariana Craiu, Statistică matematică. Teorie şi probleme, Editura Matrix Rom, 1998.
5. Mihnea Moroianu, Gheorghe Oprişan, Caiet de seminar. Probabilităţi şi statistică, Editura Printech, 2002.
6. Raluca Purnichescu-Purtan, Probabilităţi şi statistică. Teorie, exerciţii, aplicaţii în MATLAB, Editura Printech, 2015.
7. Cristina Şerbănescu, Cristina Cânepă, Culegere de probleme de probabilităţi şi procese stocastice, Editura Printech, 2016.

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Knowledge of fundamental theoretical notions. Ability to apply theoretical knowledge to problem solving.	In-term written test	40%
	Knowledge of fundamental theoretical notions. Ability to apply theoretical knowledge to problem solving.	Final exam	50%
11.5 Seminary/laboratory/project	Applying the theoretical concepts presented in the course to exercises and problems.	Systematic observation of students' activity during the seminar.	10%
11.6 Passing conditions			
• Participation in the final exam, face to face, within the scheduled time window. • 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)

The discipline "Probability Theory and Mathematical Statistics" plays an essential role in developing students' analytical and decision-making skills, meeting current labor market demands that value the ability to analyze technical data, model uncertainty, and rigorously interpret random phenomena in electronics, telecommunications, and information technologies.

The course content is aligned with the expectations of employers in fields such as electronics, telecommunications, IT, digital signal and image processing, numerical simulations, and technical research, where probabilistic and statistical methods are indispensable for risk assessment, process optimization, processing experimental data, and making evidence-based decisions. Such disciplines are also supported by professional associations and international bodies (e.g., IEEE, INFORMS, ASA) that encourage the integration of statistics and probability in modern engineering and scientific education.

The course is aligned with the practices and standards of study programs within SEÎS institutions, where emphasis is placed on developing applied mathematical competencies, using statistical software, understanding stochastic models, and applying them to concrete problems in electronics, telecommunications, and information technologies.

By completing this course, students acquire the ability to formulate hypotheses, analyze real data sets, estimate statistical parameters, and understand the behavior of random variables—fundamental elements for any engineering activity or technical research. This preparation supports career development in research, the electronics industry, signal processing, software development, or applied/scientific master's programs.

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Date	Course lecturer	Instructor(s) for practical activities
25.09.2025	Simion Emil	Tănase Roxana

Date of department approval	Head of department
26.09.2025	Prof. Dr. Claudius Dan

Date of approval in the Faculty Council	Dean
26.09.2025	Prof. Dr. Mihnea Udrea