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)				Matematici speciale Special Mathematics			
2.2 Course Lecturer				Bercia Cristina			
2.3 Instructor for practical activities				Bercia Cristina			
2.4 Year of studies	1	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		F	2.9 Course code	04.F.02.O.009		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	4	Out of which: 3.2 course	3	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	56	Out of which: 3.5 course	42	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.					54
Tutoring					10
Examinations					5
Other activities (if any):					0

3.7 Total hours of individual study	69.00
3.8 Total hours per semester	125
3.9 Number of ECTS credit points	5

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Knowledge of algebra, mathematical analysis, and geometry, according to the baccalaureate syllabus and the faculty admission syllabus. The courses “Mathematical Analysis” and “Linear Algebra, Analytic and Differential Geometry”.
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)*

“Special Mathematics” is one of the core disciplines introducing fundamental notions and techniques used in the mathematical modeling of engineering problems. It presents foundational notions of differential equations, partial differential equations, the equations of mathematical physics, complex analysis, and integral transforms (Fourier, Laplace), with an emphasis on developing reasoning. With the knowledge acquired in this course, one can explain and interpret the results of processes specific to the field. For example, the study of certain electrical circuits reduces to solving systems of linear differential equations. Furthermore, the Laplace transform reduces solving a system of differential equations to solving a system of algebraic equations. Then, the Fourier transform enables a systematic transition from time-domain signals to their frequency spectra and back—and more examples of this kind can be given.

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 the fundamental concepts needed to model and solve engineering problems and dynamic phenomena in electronics, telecommunications, and information technologies. • Applying differential equations and partial differential equations to analyze dynamic systems and simulate technical and IT processes specific to the field. • Using complex analysis and integral transforms to move systematically between the time and frequency domains, optimize algorithms, and process signals and data in engineering applications. • Developing abstract thinking and logical reasoning required to formulate, analyze, and implement complex mathematical solutions in technical projects, electronic systems, and software applications.
Transversal (General) Competences	• Mastering optimal learning methods, combining theoretical results, and developing the habit of teamwork. • Learning how to support an idea and conduct a scientific debate. • Honorable, responsible, ethical behavior, in the spirit of the law, to ensure the profession’s reputation. • Awareness of the need for continuous training; efficient use of resources and learning 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 of the studied notions. • Correlates the studied notions within and across disciplines. • Recognizes the studied notions in processes within the specialty courses. • Compares certain studied notions, 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 point of view. • Interprets a mathematical problem from a practical point of view, where applicable. • Identifies multiple approaches to solving a problem, where applicable, and proposes solution plans. • Formulates conclusions after applying the studied notions. • Anticipates stages/modes of solving.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Selects appropriate bibliographic sources and analyzes them. • Respects academic ethics, correctly citing the bibliographic sources used. • Demonstrates receptiveness to new learning contexts. • Shows collaboration with other colleagues and teaching staff in carrying out teaching activities. • Demonstrates autonomy in organizing the learning situation/context or the problem situation to be solved. • Promotes/contributes with new solutions in the field to improve the quality of social life. • Analyzes and interprets business/entrepreneurial development opportunities in the 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' learning characteristics and their specific needs, the teaching process will explore both expository methods (lecture, presentation) and conversational–interactive methods, based on discovery learning models facilitated by direct and indirect exploration of reality (demonstration, modeling), as well as action-based methods such as exercises and problem solving. Each lecture will begin with a recap of the notions covered in the previous class. This discipline includes information and practical activities designed to support students in their learning efforts and in developing optimal collaboration and communication relationships in a climate favorable to discovery learning. Emphasis will be placed on practicing active listening and assertive communication skills, as well as mechanisms for constructing feedback as ways of regulating behavior in various situations and adapting the pedagogical approach to students' learning needs.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	First-order differential equations. Existence and uniqueness of the solution for given initial conditions. Examples. Linear differential equations and linear differential systems. Basics of qualitative theory: equilibrium, periodic solution, stability, phase portrait	12
2	Autonomous systems. Trajectories and first integrals. Field lines, field surfaces, first-order quasilinear equations. Second-order partial differential equations. Reduction to canonical form and classification. Solution methods for hyperbolic- and parabolic-type equations. The Dirichlet problem	12
3	Complex functions: limit, continuity, holomorphy. Cauchy–Riemann relations. Complex integral. Cauchy's theorem. Cauchy's integral formula. Laurent series. Residue theorem. Computing real integrals using the residue theorem	9
4	Laplace transform. Applications	4
5	Z-transform. Applications	2
6	Fourier series (complex form). Fourier transform. Applications	3
	Total:	42

Bibliography:

1. Course page on the platform https://curs.upb.ro/.
2. Cristina Bercia, Romeo Bercia, *Special Mathematics. Theory and Applications*, Printech, Bucharest, 2010.
3. Mircea Cimpoeaș, *Chapters of Linear Algebra, Geometry and Differential Equations for Engineers*, Politehnica Press, Bucharest, 2021.
4. Tania-Luminița Costache, *Lessons in Special Mathematics*, Politehnica Press, Bucharest, 2017.
5. Ioana Luca, Gheorghe Oprișan, *Advanced Mathematics*, Printech, Bucharest, 2001.
6. Ana Niță, Alina Niță, *Differential Equations and Systems*, Matrix Rom, Bucharest, 2000.
7. Antonela Toma, Vladimir Slesar, *Advanced Mathematics. Problems and Exercises*, Politehnica Press, Bucharest, 2019.

SEMINARY

Crt. no.	Content	No. hours
1	First-order differential equations. Existence and uniqueness of the solution for given initial conditions. Examples	1
2	Linear differential equations and linear differential systems	2
3	Basics of qualitative theory: equilibrium, periodic solution, stability, phase portrait	1
4	Autonomous systems. Trajectories and first integrals. Field lines, field surfaces, first-order quasilinear equations	1
5	Second-order partial differential equations. Reduction to canonical form and classification	1
6	Solution methods for hyperbolic- and parabolic-type equations. The Dirichlet problem	2
7	Complex functions: limit, continuity, holomorphy. Cauchy–Riemann relations	1
8	Complex integral. Cauchy's theorem. Cauchy's integral formula	1
9	Laurent series. Residue theorem. Computing real integrals using the residue theorem	1
10	Laplace transform. Applications	1
11	Z-transform. Applications	1
12	Fourier series (complex form). Fourier transform. Applications	1
	Total:	14

Bibliography:

1. Course page on the platform https://curs.upb.ro/.
2. Cristina Bercia, Romeo Bercia, *Special Mathematics. Theory and Applications*, Printech, Bucharest, 2010.
3. Vasile Brînzănescu, Octavian Stănășilă, *Special Mathematics*, ALL, Bucharest, 1998.
4. Mircea Cimpoeaș, *Chapters of Linear Algebra, Geometry and Differential Equations for Engineers*, Politehnica Press, Bucharest, 2021.
5. Tania-Luminița Costache, *Lessons in Special Mathematics*, Politehnica Press, Bucharest, 2017.
6. Ioana Luca, Gheorghe Oprișan, *Advanced Mathematics*, Printech, Bucharest, 2001.
7. Ana Niță, Alina Niță, *Differential Equations and Systems*, Matrix Rom, Bucharest, 2000.
8. Antonela Toma, Vladimir Slesar, *Advanced Mathematics. Problems and Exercises*, Politehnica Press, Bucharest, 2019.

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.	Verification test	30%
	Knowledge of fundamental theoretical notions. Ability to apply theoretical knowledge to problem solving.	Final exam	50%
11.5 Seminary/laboratory/project	Applying the theoretical notions presented in the course to exercises and problems.	Systematic observation of students' activity during the seminar.	20%
11.6 Passing conditions			

- Participation in the final exam, face to face, during 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 course “Special Mathematics” plays an essential role in developing students’ analytical, logical, and modeling skills, addressing current labor-market demands that value the ability to mathematically model dynamic phenomena, solve complex equations, and develop efficient technical algorithms and solutions.

The course content aligns with employer expectations in fields such as electronics, telecommunications, IT, digital signal and image processing, numerical simulations, and automation, where analytical methods, differential and partial differential equations, complex analysis, and integral transforms (Fourier, Laplace) are indispensable for system design, algorithm optimization, and performance analysis. Such disciplines are also supported by international organizations and professional associations (e.g., IEEE, ACM, SIAM), which promote the integration of applied mathematics into modern engineering education.

The course is aligned with the practices and standards of study programs in SEIS institutions, emphasizing the development of applied mathematical competencies, understanding concepts of differential and partial differential equations, complex analysis, and integral transforms, as well as their application to concrete problems in electronics, telecommunications, numerical simulations, and signal and data processing.

By completing this course, students acquire the ability to analyze and solve complex mathematical problems, apply analytical methods and integral transforms in the development of algorithms and technical systems, interpret numerical results, and integrate this knowledge into applied projects. This preparation supports careers in research, the electronics and telecommunications industry, software development, signal processing, or applied/scientific master's programs.

Date	Course lecturer	Instructor(s) for practical activities
25.09.2025	Bercia Cristina	Bercia Cristina

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

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