SYLLABUS

1. Program Information

1.1 Higher education institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Department of Automation
1.4 Field of study	Automation, Applied Informatics and Intelligent Systems
1.5 Cycle of studies	Bachelor
1.6 Study Programme/Qualification	Intelligent Automation Systems (dual, in English language)
1.7 Form of education	IF – full-time education
1.8 Course code	8.00

2. Course information

2.1 Course title				**Special Mathematics**		
2.2 Course Lecturer				*Conf.dr.mat. Adrian Holhos - Adrian.Holhos@math.utcluj.ro*		
2.3 Seminar Lecturer				*Conf.dr.mat. Adrian Holhos - Adrian.Holhos@math.utcluj.ro*		
2.4 Year of study	1	2.5 Semester	2	2.6 Type of assessment		E
2.7 Course status	Formative category *(DF, DS, DC)*					DF
	Optionality *(DOB, DOP, DFac)*					DOB

3.Total estimated time

3.1 Number of hours per week	4	of which:	HEI	Lecture	2	Seminar	2	Laboratory	0	Project	0
			CO		0		0		0		0
3.2 Number of hours per semester	56	of which:	HEI	Lecture	28	Seminar	28	Laboratory	0	Project	0
			CO		0		0		0		0

3.3 Distribution of time allocation (hours per semester) for:	HEI	CO
(a) Study based on textbook, course support, bibliography, and notes	20	0
(b) Additional documentation in library, specialized electronic platforms, and fieldwork	20	0
(c) Preparation of seminars/laboratories, assignments, papers, portfolios and essays	26	0
(d) Tutoring	0	0
(e) Examinations	3	0
(f) Other activities:	0	0
3.4 Total individual study hours (sum (3.3(a)... 3.3(f)))	69	0
3.5 Total hours per semester (3.2+3.4)	125	0
3.6 Number of credits per semester	5	0

(HEI = Higher Education Institution, CO = Company)

4. Prerequisites (where applicable)

4.1 Curriculum Prerequisites	Elementary knowledge of complex numbers. Elements of calculus.
4.2 Competency Prerequisites	Competences in using complex numbers (in algebraic and trigonometric form). Ability to calculate derivatives and real integrals.

5. Conditions (where applicable)

5.1. Course Organization Conditions	Blackboard, videoprojector
5.2. Seminar organization conditions	Blackboard, videoprojector

6. Specific Competencies Acquired

Professional Competencies	• PC02 Analyse test data • PC24 Think abstractly • PC27 Execute analytical mathematical calculations
Transversal Competencies	• TC02 Think analitically • TC05 Interpret mathematical information

7. Learning outcomes

Knowledge	• Understand the algebra and topology of complex numbers and functions, including holomorphic and monogenic functions. • Grasp core theorems in complex analysis: Cauchy's integral theorem, Laurent and Taylor series, and the residue theorem. • Understand the theory and properties of Fourier, Laplace, and Z-transforms and their roles in signal and systems analysis. • Know the conditions for convergence and the applications of these transforms in solving differential and difference equations.
Skills	• Perform complex function operations and classify singularities. • Compute complex integrals and series expansions (Taylor, Laurent) around singular points. • Apply the residue theorem to evaluate complex integrals in engineering contexts. • Calculate and interpret continuous and discrete Fourier transforms, including using the FFT algorithm. • Use Laplace and Z-transforms (and their inverses) to solve ordinary differential and difference equations. • Apply transforms to analyze linear systems, control processes, and signal processing problems.
Responsibility and autonomy	• Select and apply the appropriate mathematical tools (complex analysis or transform methods) to model, simplify, and solve engineering problems. • Show responsibility in validating mathematical solutions and interpreting their physical significance. • Work independently and collaboratively in mathematical modeling tasks, especially when evaluating system behavior in the time and frequency domains.

8. Course Objectives

8.1 General objective of the course	Understanding and assimilation of concepts, principles, methods, and fundamental techniques used in complex functions theory and integral transforms theory with applications in System Engineering.
8.2 Specific objectives	• Operating with complex numbers, functions, series. Operating with integral and discrete transforms (Fourier, Laplace, Z) • Use of the complex functions theory and integral transforms theory for solving problems in engineering.

9. Contents

9.1 Lectures	No. of hours	Teaching methods	Obs.
C1. Operations with complex numbers.	2	Interactive lecturing, case-based teaching, conceptual walkthroughs.	-
C2. Topology in C. Functions defined in C. Monogenic functions.	2		
C3. Holomorphic functions. Elementary functions.	2		
C4. The complex integral. Cauchy's integral theorem and integral formula. Singular points, classification.	2		
C5. Taylor series. Laurent series.	2		
C6. The Residue Theorem. Applications.	2		
C7. The integral Fourier transform.	2		
C8. Convolution product. Applications of the Fourier transform.	2		
C9. The discrete Fourier transform. Fast Fourier Transform Algorithm	2		
C10. The Laplace transform.	2		
C11. The inverse Laplace transform.	2		
C12. Application of the Laplace transform	2		
C13. The directe and inverse Z transform.	2		
C14. Application of the Z transform	2		

Bibliography

[1] S. Lang, *Complex Analysis*, Springer Science&Business Media, New York, 1999

[2] B.G. Osgood, *Lectures on Fourier Transforms and its Applications*, American Mathematical Society, 2019

[3] U. Graf, *Applied Laplace Transforms and Z-Transforms for Scientists and Engineers*, Birkhauser Verlag, 2004

[4] Mitrea, A. *Matematici speciale: analiză matematică în complex: transformări integrale şi discrete*, Mediamira, 2015 (in Romanian)

[5] Mitrea, A. *Matematici speciale: analiză matematică în complex: transformări integrale şi discrete*, Mediamira, 2007 (in Romanian, in TUNC library)

[6] I. Gavrea, *Matematici speciale*, Mediamira, Cluj-Napoca, 2006 (in Romanian)

9.2 Seminar	Hours HEI	Hours CO	Teaching methods	Obs.
S1. Operations with complex numbers.	2	0		
S2. Topology in C. Functions defined in C.	2	0		
S3. Holomorphic functions. Elementary functions.	2	0		
S4. The complex integral. Cauchy's integral theorem and integral formula. Singular points, classification.	2	0		
S5. Taylor series. Laurent series. Applications.	2	0		
S6. The Residue Theorem.	2	0		
S7. Applications of Residue Theorem.	2	0		
S8. The integral Fourier transform.	2	0		
S9. Convolution product. Applications of the Fourier transform.	2	0		
S10. The discrete Fourier transform.	2	0		
S11. The Laplace transform.	2	0		
S12. The inverse Laplace transform.	2	0		
S13. The directe Z transform.	2	0		

S14. The inverse Z transform.	2	0		

Bibliography

[1]. I. Gavrea, *Matematici speciale -Culegere de probleme*, Mediamira, 2007 (in Romanian).

10. Correlation of course content with the expectations of the epistemic community representatives, professional associations, and major employers in the field related to the program

The course content is closely aligned with the expectations of the academic and professional communities by providing essential analytical tools—such as complex analysis and integral transforms—that are fundamental in engineering, control systems, signal processing, and applied research, thereby meeting the competency demands of major employers and international standards in technical fields.

11. Evaluation

Activity Type	**Evaluation criteria**	**Evaluation methods**	**Weight in final grade**
11.1 Lecture	Written exam		80%
11.2 Seminar	Seminar activity		20%
11.3 Minimum Performance Standard			
Grade = 80% Written Exam + 20% Seminar Activity. Minimum Performamce Standard: Written Exam≥5 and Grade≥5.			

Date of completion: 15.05.2025	Lecturers	Title First Name LAST NAME	Signature
	Course	Assoc. Prof. PhD Math. Adrian HOLHOS	
	Applications	Assoc. Prof. PhD Math. Adrian HOLHOS	

Date of approval by the Department of Automation Council 24.11.2025	Director of the Department of Automation Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Faculty of Automation and Computer Science Council 28.11.2025	Dean Prof.dr.ing. Vlad MUREȘAN