SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Automation and Computer Science
1.3 Department	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / qualification	Computer Science / Engineer
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Mathematical analysis II (Integral calculus and differential equations)***			Subject code	**8**
2.2 Course responsible / lecturer	Prof. Ivan Dumitru-Mircea, Ph.D. math. - mircea.ivan@math.utcluj.ro Assoc. prof. Rus Mircea, Ph.D. math. - rus.mircea@math.utcluj.ro				
2.3 Teachers in charge of seminars / laboratory / project	Assoc. prof. Rus Mircea, Ph.D. math. - rus.mircea@math.utcluj.ro				
2.4 Year of study	I	2.5 Semester	1	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DF – fundamental, DS – specialty, DC – complementary				DF
	Optionality: DOB – mandatory, DOP – optional (alternative), DFA – optional (free choice)				DOB

3. Estimated total time

3.1 Number of hours per week	4	of which:	Course	2	applications	2
3.4 Total hours in the teaching plan	56	of which:	Course	28	applications	28
3.3 Individual study						
a) Manual, lecture material and notes, bibliography						28
b) Supplementary study in the library, online, and in the field						7
c) Preparation for seminars / laboratory works, homework, reports, portfolios, essays						28
d) Tutoring						3
e) Exams and tests						3
f) Other activities						-

3.4 Total hours of individual study	69
3.5 Total hours per semester	125
3.6 Number of credit points	5

4. Pre-requisites (where appropriate)

4.1 Curriculum	Mathematical analysis: high school, 12th grade, M1 profile 1.00 Mathematical analysis I (Differential calculus): year 1, semester 1
4.2 Competence	Competence of the above curriculum

5. Requirements (where appropriate)

5.1 For the lectures	Whiteboard, chalk / marker; video projector, computer, graphics tablet; software tools for mathematical visualization and computation (GeoGebra, Desmos, Python – SymPy/NumPy/SciPy/Matplotlib); online learning platforms (Microsoft Teams); AI-based digital assistants used for exploring concepts, verifying reasoning, and supporting individual study.
5.2 For the applications	Whiteboard, chalk / marker; video projector, computer, graphics tablet; software tools for mathematical visualization and computation (GeoGebra, Desmos, Python – SymPy/NumPy/SciPy/Matplotlib); online learning platforms (Microsoft Teams); AI-based digital assistants used for exploring concepts, verifying reasoning, and supporting individual study.

6. Specific competences

6.1 Professional competences	**C1 –** Operating with basic mathematical, engineering, and computer science concepts • **C1.1 –** Recognizing and describing concepts that are specific to the fields of calculability, complexity, programming paradigms, and modeling computational and communication systems • **C1.2** – Using specific theories and tools (algorithms, schemes, models, protocols, etc.) to explain the structure and operation of hardware, software, and communication systems • **C1.3 –** Building models for various components of computing systems • **C1.4** – Formal evaluation of functional and non-functional characteristics of computing systems • **C1.5 –** Providing a theoretical background for the characteristics of the designed systems
6.2 Cross competences	N/A

7. Expected Learning Outcomes

Knowledge	Describe, identify, and summarize elementary concepts and methods related to the mathematical modeling of systems using integral calculus and differential equations, namely: • First-order ordinary differential equations; higher-order linear equations with constant coefficients; solution methods and associated mathematical models. • Integral calculus: the Riemann–Stieltjes integral, improper integrals, parameter-dependent integrals, special functions (Gamma, Beta). • Line integrals and differential forms; multiple and surface integrals: the Green–Riemann, Stokes, and Gauss–Ostrogradsky formulas.
Skills	Uses specific methods to solve ordinary differential equations and to compute integrals. Interprets the obtained results geometrically and physically. Analyzes and mathematically models engineering problems using the tools of integral calculus and differential equations. Uses specialized software tools (symbolic/numerical computation environments, mathematical visualization platforms) to analyze, simulate, and verify the obtained solutions.
Responsibilities and autonomy	Demonstrates honorable, responsible, and ethical conduct, in accordance with the law, to uphold the reputation of the profession.

8. Discipline objectives (as results from the *key competencies gained*)

8.1 General objective	Knowledge of the fundamentals of integral calculus and differential equations from the perspective of their application in engineering.
8.2 Specific objectives	Knowledge of fundamental notions, methods, and techniques regarding ordinary differential equations, integrals, and special functions; their application in the mathematical modeling of engineering problems and their solution.

9. Contents

9.1 Lecture (syllabus)	Hours	Teaching methods	Notes
Introduction to Ordinary differential equations (ODEs). Mathematical models based on ODEs.	1	Exposition; problem-based learning and discovery learning; demonstration; collaboration; independent study. Demonstration supported by digital tools for mathematical visualization and computation.	
ODEs of order one in the explicit form: separable ODEs, homogeneous ODEs, linear ODEs, Bernoulli's ODEs, Riccati's ODEs.	2		
ODEs of order one in the implicit form: Clairaut's ODEs, Lagrange's ODEs.	1		
Linear ODEs of higher order with constant coefficients: homogeneous, non- homogeneous; the method of variation of constants.	2		
Positive and linear functionals. The Riemann-Stieltjes integral. Primitives.	2		
Improper integrals.	2		
Integrals that depend on parameters.	2		
Special functions.	2		
Paths. The line integral with respect to the length. The line integral with respect to the coordinates. Differential forms. Exact differential forms. Path-independence of line integrals. Geometric and physical applications of line integrals.	3		

The double integral. The Green-Riemann Formula.	2		
The surface integral with respect to the area. The surface integral with respect to the coordinates. The Stokes Theorem. Geometric and physical applications of surface integrals.	3		
The triple integral. The Gauss-Ostrogradsky Theorem.	2		

Bibliography:

1. Mircea Ivan. *Elemente de calcul integral*. Mediamira, Cluj-Napoca, 2003. ISBN 973-9357-40-7.
2. Dumitru Mircea Ivan. *Calculus. Editura Mediamira*, Cluj-Napoca, 2002. ISBN 973-9358-88-8.
3. Alina Sîntămărian, Ovidiu Furdui. *Teme de analiză matematică. Exerciții și probleme* (ediția a VI-a, revăzută și adăugită), Editura Mega, Cluj-Napoca, 2019. ISBN: 978-606-020-117-5
4. Alina Sîntămărian, Ovidiu Furdui. *Teme de calcul integral. Exerciții și probleme* (ediția a II-a, revăzută și adăugită), Editura Mega, Cluj-Napoca, 2020. ISBN: 978-606-020-197-7
5. Alina Sîntămărian, Ovidiu Furdui. *Sharpening Mathematical Analysis Skills*. Problem Books in Mathematics, Springer, Cham, 2021. ISBN: 978-3-030-77138-6
6. Gilbert Strang, Edwin Herman, *Calculus, Volume 2*, OpenStax, Rice University, 2016 (open access): https://openstax.org/details/books/calculus-volume-2
7. Gilbert Strang, Edwin Herman, *Calculus, Volume 3*, OpenStax, Rice University, 2016 (open access): https://openstax.org/details/books/calculus-volume-3
8. Paul Dawkins, *Paul's Online Math Notes – Differential Equations & Calculus III*: https://tutorial.math.lamar.edu/

9.2 Applications - Seminars / Laboratory / Project	Teaching methods	Notes
The topics covered in the seminars are identical to those in the lectures (see 9.1); they are completed in the same order and take the same number of hours. The theoretical aspects covered in the lectures are illustrated by examples, problem- solving and specific applications.	The conversation; problem solving and discovery learning; the analogy; the exercise; modeling; homework and individual study; collaboration.	

Bibliography:

1. Dumitru Mircea Ivan, et al. *Analiză matematică - Culegere de probleme pentru seminarii, examene și concursuri*. Editura Mediamira, Cluj-Napoca, 2002. ISBN 973-9357-20-2.
2. Mircea Ivan et al. *Culegere de probleme pentru seminarii, examene si concursuri*. UT Press, Cluj-Napoca, 2000.
3. Alina Sîntămărian, Ovidiu Furdui. *Teme de analiză matematică. Exerciții și probleme* (ediția a VI-a, revăzută și adăugită), Editura Mega, Cluj-Napoca, 2019. ISBN: 978-606-020-117-5
4. Alina Sîntămărian, Ovidiu Furdui. *Teme de calcul integral. Exerciții și probleme* (ediția a II-a, revăzută și adăugită), Editura Mega, Cluj-Napoca, 2020. ISBN: 978-606-020-197-7
5. Alina Sîntămărian, Ovidiu Furdui. *Sharpening Mathematical Analysis Skills*. Problem Books in Mathematics, Springer, Cham, 2021. ISBN: 978-3-030-77138-6
6. Gilbert Strang, Edwin Herman, *Calculus, Volume 2 & Volume 3*: https://openstax.org/subjects/math
7. Paul Dawkins, *Paul's Online Math Notes – Practice Problems*: https://tutorial.math.lamar.edu/

10. Bridging course contents with the expectations of the representatives of the community, professional associations, and employers in the field

Mathematical analysis is a core discipline in mathematics. The discipline's content is almost identical to that of other technical universities in the country and abroad and is adapted to the requirements in the field of engineering sciences.

11. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	Ability to understand and use the concepts and proofs creatively	Written examination	40%
Applications	Ability to solve problems.	Written examination and continuous evaluation during the semester	60%

* For details (according to Art 6.3-2 of the REGULATION REGARDING THE PROFESSIONAL ACTIVITY OF STUDENTS USING THE ECTS SYSTEM): the student evaluation methods and the evaluation criteria will be brought to the student's attention by the teaching staff at the first teaching activity. They cannot change during the current year.

Date of filling in: 27.04.2026	**Responsible**	**Title, First name Last name**	**Signature**
	Course	Prof. Ivan Dumitru-Mircea, Ph.D. math.	
		Assoc. prof. Rus Mircea, Ph.D. math	
	Applications:	Assoc. prof. Rus Mircea, Ph.D. math	

Date of approval by the Department Board	Head of Department of Mathematics, Prof.univ.dr. Dorian Popa
Date of approval by the Faculty Council	Dean, Prof.dr.eng. Vlad Mureșan