COURSE DESCRIPTION

Symplectic Geometry and Topology

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Universitatea Babeş-Bolyai
1.2. Faculty	Faculty of Mathematics and Computer Science
1.3. Doctoral Shool	Matematica-Informatica
1.4. Field of study	Doctoral studies
1.5. Level of study	Training program based on advanced academic studies

2. Course-related data

2.1. Course title	**Symplectic Geometry and Topology**			Course code	MDE8173
2.2. Course coordinator	Pintea Cornel-Sebastian				
2.3. Seminar coordinator	Pintea Cornel-Sebastian				
2.4. Year of study	I	2.5. Semester	I	2.6. Type of assessment	Exam
2.7. Course status		Optional		2.8. Course type	Core subject

3. Total estimated time (hours per semester of teaching activities)

3.1. Number of hours per week	3	of which: 3.2. course	2	3.3. seminar/ laboratory/ project	1
3.4. Total of hours in the curriculum	36	of which: 3.5. course	24	3.6. seminar/ laboratory	12
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS) 60					
Additional research in the library, on subject-specific electronic platforms, and on-site 50					
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays 70					
Tutoring (professional guidance) 20					
Examinations 14					
Other activities					
3.7. Total hours of individual study (IS) and self-taught activities (ST)				214	
3.8. Total hours per semester				250	
3.9. Number of credits				10	

4. Prerequisites (where applicable)

4.1. curriculum-related	Differential geometry and differential topology
4.2 skills-related	Knowledge of classical and modern techniques of differential geometry and topology Comparative evaluation and efficient use of different demonstration methods

5. Specific conditions (where applicable)

5.1. course-related	Room with a board (inteligent if posible)
5.2. seminar/laboratory-related	Room with a board (inteligent if posible)

6. Subject-specific learning outcomes

Knowledge
1. The students will understand that Symplectic Geometry has its roots in the Hamiltonian formulation of classical mechanics
2. The students will have a good understanding of symplectic, contact, complex and almost complex structures.
3. The students will understand the locally Euclidean nature of the set of Lagrangian subspaces and the associated Maslov index
4. The students will understand the role of symplectic geometry in defining the Poisson bracket and the connection between it and the Lie bracket via Hamiltonian vector fields.
5. The students will have a good understanding of the concept of symplectic manifold and of some important results involving symplectic structures such as Darboux's Theorem and the nonsqueezing Theorem.
6. The students will understand some elements of homotopy theory and algebraic topology that arise from symplectic structures. For example, the contractibility of the space as Sp(2n)/U(n) and the Maslov index of the group Sp(2n) of all symplectomorphisms of R^{2n}.
Skills
1. The students will be able to give examples of some main classes of symplectic, contact, complex and almost complex manifolds and of the way in which some of them interact.
2. The students will know some techniques for studying Lagrangian properties.
3. The students will be able to give sufficient conditions, in terms of the first DeRham cohomology group, for the existence of two fixed points of symplectomorphisms sufficiently close to the identity of a symplectic manifold.
Responsibility and autonomy
1. The students will have developed abilities in designing and presenting a topic with an advanced degree of complexity from the classical literature of symplectic geometry and topology.
2. The students will have good abilities in assimilating topics related to current research in the field of symplectic geometry and topology
3. The students will acquire the potential applications of symplectic geometry and topology both in practical fields and in other fields of mathematics.

7. Contents

7.1. Course	**Teaching and learning methods**	**Remarks**[1]
Differential Geometry revisited.	Exposure: description, explanation, examples	
Hamiltonian mechanics. The sympletic topology of the Euclidean space	Exposure: description, explanation, examples, proofs.	
Hamiltonian and Lagrange systems	Exposure: description, explanation, examples, proofs.	
Linear symplectic geometry	Exposure: description, explanation, examples, proofs.	
Isotropic, Coisotrpic and Lagrangian subspaces	Exposure: description, explanation, examples, proofs	
The Arnold conjecture and the nonsqueezing theorem	Exposure: description, explanation, examples	
The group of symplectomorphisms	Exposure: description, explanation, examples, proofs.	
The Maslov index	Exposure: description, explanation, examples, proofs.	

[1] For example, organisational aspects, recommendations for students, specific aspects relating to the course/seminar, such as inviting experts in the field, etc.

Symplectic manifolds, contact manifolds. Complex structures and almost complex structures	Exposure: description, explanation, examples, proofs.	
Bibliography		
7.2. Seminar/ laboratory	**Teaching and learning methods**	**Remarks**
Geometrie diferentiala. Recapitulare	Explanation, dialogue, examples.	
Hamiltonians and Hamiltionian flows.	Explanation, dialogue, examples.	
Examples and properties of symplectic forms.	Explanation, dialogue, examples.	
Symplectomorphisms and Hamiltonian diffeomorphisms. The isotopy relation.	Explanation, dialogue, examples.	
Properties and relations involving the general linear group, the unitar group, the orthogonal group and the group of sumplectomorphisms	Explanation, dialogue, examples.	
The Riemannian structure induced by a symplectic structure. Examples of volume preserving diffeomorphisms, symplectomorphismss and symplectic capacities.	Explanation, dialogue, examples.	
Hamiltonian vector fields and the Poisson bracket	Explanation, dialogue, examples.	
Periodic and nonperiodic solutions of the Hamiltonian system	Explanation, dialogue, examples.	
Bibliography		

8. Evaluation

Type of activity	8.1 Evaluation criteria[2]	8.2 Evaluation methods[3]	8.3 Percentage in the final grade
8.4. Course	One theoretical research reports on current research topics of Symplectic Geometry and Topology, based on some recent research paper(s) should be prepared and presented.	Evaluation of the research report (a written paper of about and an oral presentation)	45%
	The correctness and completeness of the accumulated knowledge.	Oral assessment	
8.5. Seminar/ laboratory	One theoretical report based on classical topics of Symplectic Geometry and Topology.	Evaluation of the research report (a written paper of about and an oral presentation).	45%
	Class attendance (lectures, seminar) and activity		10%
8.6 Minimum standard for passing			
The students have to acquire an acceptable level of knowledge and understanding of Symplectic Geometry along with reasonably good abilities to state these knowledges and solve problems. Successful passing of the exam is conditioned by the final grade that has to be at least 5			

[2] The evaluation criteria must directly reflect the learning outcomes targeted at the level of the degree programme respectively at the level of the subject. More specifically, the learning outcomes set out in the expected learning outcomes are assessed.

[3] Both final evaluation methods and ongoing evaluation strategies should be established.

9. SDG labels (Sustainable Development Goals)[4]

Not applicable

Date of entry: 15.02.2026	Signature of course coordinator	Signature of seminar coordinator
	Cornel Pintea	Cornel Pintea

Date of approval in the department:

Signature of the head of department

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[4] Select a single label which, according to the *Implementation of SDG labels in the academic process*, best matches the subject. If the subject addresses sustainable development in a generic manner (i.e. by presenting/introducing the general framework of sustainable development, etc.), then the Sustainable Development generic label may be applied. If none of the labels describe the subject, select the last option: *"No label applies."*