SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babeş-Bolyai University Cluj-Napoca
1.2 Faculty	Faculty of Mathematics and Computer Science
1.3 Department	Department of Mathematics
1.4 Field of study	Mathematics
1.5 Study cycle	Master
1.6 Study programme / Qualification	Applied Mathematics

2. Information regarding the discipline

2.1 Name of the discipline	**Continuum mechanics (Mecanica mediilor continue)**						
2.2 Course coordinator			Prof. Dr. Mirela KOHR				
2.3 Seminar coordinator			Prof. Dr. Mirela KOHR				
2.4 . Year of study	2	2.5 Semester	4	2.6. Type of evaluation	E	2.7 Type of discipline	**DS**

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1 sem
3.4 Total hours in the curriculum	**36**	Of which: 3.5 course	**24**	3.6 seminar/laboratory	**12**
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					48
Additional documentation (in libraries, on electronic platforms, field documentation)					26
Preparation for seminars/labs, homework, papers, portfolios and essays					48
Tutorship					9
Evaluations					8
Other activities:					-

3.7 Total individual study hours	139
3.8 Total hours per semester	175
3.9 Number of ECTS credits	7

4. Prerequisites (if necessary)

4.1 curriculum	• Theoretical mechanics; Fluid mechanics; Partial differential equations; Complex analysis; Numerical analysis
4.2 competencies	• There are useful logical thinking and mathematical notions and results from the above mentioned fields

5. Conditions (if necessary)

5.1 for the course	• Classroom with blackboard/video projector
5.2 for the seminar /lab activities	• Classroom with blackboard/video projector

6. Specific competencies acquired

Professional competencies	• Ability to understand and manipulate concepts, individual results and advanced mathematical theories. • Ability to model and analyze from the mathematical point of view real processes from other sciences, fluid mechanics and porous media, elasticity, and engineering. • Ability to use scientific language and to write scientific reports and papers.
Transversal competencies	• Ability to inform themselves, to work independently or in a team in order to carry out studies and to solve complex problems. • Ability to use advanced and complementary knowledge in order to obtain a PhD in Pure Mathematics, Applied Mathematics, or in other fields that use mathematical models. • Ability for continuous self-perfecting and study.

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• Knowledge, understanding and use of main concepts and results of continuum mechanics. • Knowledge, understanding and combine advances mathematical methods in the theory of partial differential equations, complex analysis, potential theory and fixed point theory in the study of some elliptic boundary value problems in fluid mechanics, porous media, elasticity, and other sciences.
7.2 Specific objective of the discipline	• Acquiring basic and advanced knowledge in kinematics, dynamics and thermodynamics of continuum media. • Knowledge, understanding and use mathematical models in the description and analysis of various problems in continuum mechanics. • Knowledge, understanding and use the results of complex analysis in the study of boundary value problems related to ideal fluid flows. • Knowledge, understanding and use of advanced topics in mathematics in the study of elliptic boundary value problems for the Lamé, Stokes, and Brinkman systems. • Ability student involvement in scientific research.

8. Content

8.1 **Course**	Teaching methods	Remarks
1. Kinematics of continuous media. Material description of the motion of continuous media. The linearized theory of deformation.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
2. Dynamics of continuous media. General results. Principles of thermodynamics and the energy equation.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	

3. Mathematical models of continuum mechanics. The ideal fluid and the motion equations. Uniqueness theorems and applications.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
4. The potential flow of ideal incompressible fluid (I): The real potential and the stream function. Complex potential. Complex velocity. The inverse method.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
5. The potential flow of ideal incompressible fluid (II): The complex potentials of source and vortex. The potential flow of ideal incompressible fluid past a solid cylinder.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
6. The potential flow of ideal incompressible fluid (III): The Riemann mapping theorem. Applications to the flow past a solid body.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
7. Mathematical model of viscous Newtonian fluid. The Navier-Stokes equations. Uniqueness theorems and applications.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
8. Boundary value problems for elliptic systems in Lipschitz domains with applications in fluid mechanics and porous media.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
9. Nonlinear boundary value problems for the Navier-Stokes and Brinkman systems. Existence results in Sobolev spaces by using the potential theory and the fixed point theory. Applications (I).	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
10. Nonlinear boundary value problems for the Navier-Stokes and Brinkman systems. Existence results in Sobolev spaces by using the potential theory and the fixed point theory. Applications (II).	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
11. The linear theory of Elasticity. Constitutive equation. The Lamé system. Uniqueness theorems and applications.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	
12. Boundary value problems for the Lamé system in Lipschitz domains. Existence and uniqueness results in Sobolev spaces.	Lectures, modeling, didactical demonstration, conversation. Presentation of alternative explanations.	

Bibliography

1. Kohr, M., *Modern Problems in Viscous Fluid Mechanics*, Cluj University Press, Cluj-Napoca, 2 vols. 2000 (in Romanian).
2. Kohr, M., Pop, I., *Viscous Incompressible Flow for Low Reynolds Numbers*, WIT Press (Wessex Institute of Technology Press), Southampton (UK) – Boston, 2004.
3. Dragoş, L., *Principles of Mechanics of Continuous Media*, Editura Tehnică, Bucureşti, 1981 (in Romanian).

4. Truesdell, C., *A First Course in Rational Continuum Mechanics*, Vol. 1, Academic Press, New-York, 1991.
5. Mitrea, M., Wright, M., *Boundary value problems for the Stokes system in arbitrary Lipschitz domains*, Astérisque, 344 (2012), viii+241 pp.
6. Atanackovic, T.M., Guran, A., *Theory of Elasticity for Scientists and Engineers*, Birkhäuser, Boston, 2000.
7. Hunter, S.C., *Mechanics of Continuous Media*, Ellis Horwood Ltd., 1983.
8. Hsiao, G.C., Wendland W.L., *Boundary Integral Equations*, Springer-Verlag, Heidelberg, 2008.
9. Precup, R., *Linear and Semilinear Partial Differential Equations*, De Gruyter, Berlin, 2012.
10. Gilbarg, D., Trudinger, N.S., *Elliptic Partial Differential Equations of Second Order*, Springer, Berlin, 2001.

8.2 **Seminar**	Teaching methods	Remarks
1. Kinematics of continuous media.	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week
2. Dynamics of continuous media. Principles of thermodynamics.	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week
3. The conservation theorems for ideal fluids.	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week
4. The Helmholtz equation.	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week
5. The complex potential of doublet. The two-dimensional potential flow of ideal fluid past a circular body.	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week
6. Applications of conformal mapping theory to the study of two-dimensional potential flows of incompressible ideal fluids.	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week
7. Applications of conformal mapping theory to the study viscous incompressible fluid flows.	Applications of course concepts. Description of	1 hour/week

	arguments and proofs for solving problems. Homework assignments. Direct answers to students.	
8. Exact solutions of the Navier-Stokes equations. The plane Poiseuille flow. Flow in a circular cylinder.	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week
9. Boundary value problems for the Stokes and Brinkman systems in Lipschitz domains. Applications.	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week
10. Nonlinear boundary value problems for the Navier-Stokes and Brinkman systems. Applications (I).	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week
11. Nonlinear boundary value problems for the Navier-Stokes and Brinkman systems. Applications (II).	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week
12. Mathematical model of elastic media. Boundary value problems for the Lamé system in Lipschitz domains.	Applications of course concepts. Description of arguments and proofs for solving problems. Homework assignments. Direct answers to students.	1 hour/week

Bibliography

1. Kohr, M., *Modern Problems in Viscous Fluid Mechanics*, Cluj University Press, Cluj-Napoca, 2 vols. 2000 (in Romanian).
2. Kohr, M., Pop, I., *Viscous Incompressible Flow for Low Reynolds Numbers,* WIT Press (Wessex Institute of Technology Press), Southampton (UK) – Boston, 2004.
3. Dragoş, L., *Principles of Mechanics of Continuous Media*, Editura Tehnică, Bucureşti, 1981 (in Romanian).
4. Truesdell, C., *A First Course in Rational Continuum Mechanics*, Vol. 1, Academic Press, New-York, 1991.
5. Hunter, S.C., *Mechanics of Continuous Media*, Ellis Horwood Ltd., 1983.
6. Atanackovic, T.M., Guran, A., *Theory of Elasticity for Scientists and Engineers*, Birkhäuser, Boston, 2000.
7. Hsiao, G.C., Wendland W.L., *Boundary Integral Equations*, Springer-Verlag, Heidelberg, 2008.

8. Sohr, H., *The Navier-Stokes Equations: An Elementary Functional Analytic Approach*, Birkhäuser Verlag, Basel 2001.

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- The content of this discipline is in accordance with the curricula of the most important universities in Romania and abroad, where the applied mathematics plays an essential role. This discipline is useful in preparing future teachers and researchers in applied mathematics, as well as those who use mathematical models and advanced methods of study in other areas.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Knowledge of concepts and basic results	Written exam at the end the semester.	60%
	Ability to justify by proofs theoretical results		
10.5 Seminar/lab activities	Ability to apply concepts and results acquired in the course to solve certain problems in continuum mechanics.	Evaluation of reports and homework during the semester, and active participation in the seminar activity. A midterm control work.	40%
	There are valid the official rules of the faculty concerning the attendance of students to teaching activities.		
10.6 Minimum performance standards			
• At least grade 5 (from a scale of 1 to 10) at both written exam and seminar activity during the semester.			

Date	Signature of course coordinator	Signature of seminar coordinator
2.05.2015	Prof. Dr. Mirela KOHR	Prof. Dr. Mirela KOHR

Date of approval — Signature of the head of department

.... — Prof. Dr. Octavian AGRATINI