SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babeş-Bolyai University Cluj-Napoca
1.2 Faculty	Chemistry and Chemical Engineering
1.3 Department	Chemical Engineering
1.4 Field of study	Chemical Engineering
1.5 Study cycle	Master
1.6 Study programme / Qualification	**Advanced Chemical Process Engineering)**/ Master Chemical Engineer

2. Information regarding the discipline

2.1 Name of the discipline	**Rheology of disperse systems - CME7314**						
2.2 Course coordinator	Assoc. Prof. Dr. Eng. Adina MICLĂUŞ						
2.3 Seminar coordinator	Assoc. Prof. Dr. Eng. Adina MICLĂUŞ						
2.4 Year of study	I	2.5 Semester	1	2.6. Type of evaluation	E	2.7 Type of discipline	DS/Comp

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

3.1 Hours per week	4	Of which: 3.2 curs	2	3.3 seminar/laboratory	1/1
3.4 Total hours in the curriculum	56	Of which: 3.5 curs	28	3.6 seminar/laboratory	14/14
Time allotment:					ore
Learning using manual, course support, bibliography, course notes					28
Additional documentation (in libraries, on electronic platforms, field documentation)					14
Preparation for seminars/labs, homework, papers, portfolios and essays					23
Tutorship					2
Evaluations					2
Other activities:					

3.7 Total individual study hours	69
3.8 Total hours per semester	125
3.9 Number of ECTS credits	5

4. Prerequisites (if necessary)

4.1. curriculum	• Not necessary
4.2. competencies	• Not necessary

5. Conditions (if necessary)

5.1. for the course	Students will be present at lectures, seminars and laboratories with phones turned off.
5.2. for the seminar /lab activities	• Students will be present at the laboratories with the paper written and studied. • Students will be present at the laboratories with the robe. • Students may not leave operating apparatus. • Laboratory reports will be done no later than the last week of the teaching activity. • Delay will be penalized.

6. Specific competencies acquired

Professional competencies	Development of processes, machines and equipment specific to the process engineering by promoting new solutions to improve processes, optimal operation and control • Use of creative expertise, methods and concepts for analysis and synthesis of new chemical processes. • Use of integrated chemical analysis and synthesis for process development and production of innovative products. • Application of performance evaluation of new modern facilities to improve the decision concerning processes and synthesis.
Transversal competencies	• Realization of tasks according to the demands and in require terms, with the respect of the ethical professional norms • Solving the tasks according to the general objective established in the work group • Permanent information and documentation in the field.

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

7.1 General objective	• Knowledge of principles, methods and mechanisms of the bodies' behavior (fluids, solids) subjected to flow/distortion which appears during the real industrial processes.
7.2 Specific objectives	• The ability to establish and to choose the models proper to the studied properties of materials, applying the correct research methods.

8. Content

8.1 Course	Teaching methods	Remarks
8.1.1. Introduction. Fundamental concepts of rheology. Specific deformation, shear stress, shear rate. Flow behavior and viscosity. Influence of temperature on viscosity. Elasticity of materials.	Lecture Discussion	
8.1.2. Systems with uniform properties Linear rheological behavior of fluids with uniform properties (Newton's fluid, Hook's solid and St. Venant's plastic). Model functions for systems with ideal behavior.	Lecture Discussion	
8.1.3. Viscous fluids with non-Newtonian time-independent behavior Fluids with time-independent structure (shear-thinning or pseudo-plastic flow behavior, shear-thickening or dilatants flow behavior). Rheological model functions, specific flow curves and viscosity functions.	Lecture Discussion	
8.1.4. Viscous fluids with non-Newtonian time-independent behavior. Yield point. Determination of the yield point. Rheological model functions for flow	Lecture Discussion	

curves including a yield point.		
8.1.5. Viscous fluids with non-Newtonian time-dependent behavior Time-dependent fluid flow behavior (thixotropic fluids). Rheological model functions, specific flow curves and viscosity functions. Structural decomposition and regeneration. Test methods.	Lecture Discussion	
8.1.6. Viscous fluids with non-Newtonian time-dependent behavior Time-dependent fluid flow behavior (rheopexic fluids). Rheological model functions, specific flow curves and viscosity functions. Structural decomposition and regeneration. Test methods.	Lecture Discussion	
8.1.7. Materials with multiple properties Introduction. Viscoelastic behavior. Basic principles. Theoretical and mechanical models for viscoelastic liquids (Maxwell) and viscoelastic solids (Voigt-Kelvin). Complex models: Burgers, Lethersich, Zener. Creep and creep recovery curves. Examples of the behavior of viscoelastic materials in practice.	Lecture Discussion	
8.1.8. Materials with multiple properties Oscillatory tests - “dynamic mechanical analysis” (DMA). Elastic behavior and characteristic rheological parameters. Specific tests: amplitude sweep, frequency sweep and temperature sweep.	Lecture Discussion	
8.1.9. Rheology of polymeric liquid systems Rheological behavior of colloidal solutions. Factors which influence the viscosity and rheological behavior of solutions.	Interactive lecture	
8.1.10. Rheology of polymeric liquid systems Rheological behavior of emulsions and gels. Factors which influence the viscosity and rheological behavior of emulsions and gels.	Lecture Discussion	
8.1.11. Rheology of polymeric liquid systems Rheological behavior of suspensions and pastes. Influence of different factors on viscosity and rheological behavior. Complex fluids.	Lecture Discussion	
8.1.12. Rheometry. Rheological measurements in static regime. Rotational rheometers. Measuring systems and specific tests.	Lecture Discussion	
8.1.13. Rheometry. Rheological measurements in dynamic regime. Oscillatory rheometers. Measuring systems and specific tests.	Lecture Discussion	
8.1.14. Rheometry. Temperature-dependent flow behavior (rotation). Temperature-dependent visco-elastic behavior (oscillation).	Lecture Discussion	

Bibliography

1. R. Z. Tudose, T. Volintiru, N. Asandei, M. Lungu, E. Merică şi Gh. Ivan, „Reologia compuşilor macromoleculari, I. Introducere în reologie”, Ed. Tehnică, Bucureşti, 1982
2. R. Z. Tudose, T. Volintiru, N. Asandei, M. Lungu, E. Merică şi Gh. Ivan, „Reologia compuşilor macromoleculari, II. Reologia stării lichide”, Ed. Tehnică, Bucureşti, 1984
3. R.P. Chhabra, J. F. Richardson, „Non-Newtonian Flow in the process Industries. Fundamentals and Engineering Applications”, Ed. Butterworth Heinemann, 1999
4. R. Z. Tudose, „Ingineria proceselor fizice din industria chimică”, Ed. Academiei Române, vol.I Fenomene de transfer, 2000
5. N. Teodorescu, **„**Reologie Aplicată”, Ed. Matrix Rom, Bucureşti, 2004
6. Adina L. Ghirişan, „Separarea fizico-mecanică a sistemelor eterogene solid-lichid”, Ed. Casa Carţii de Ştiintă, Cluj-Napoca, (subcap. Comportarea reologică a sistemelor eterogene solid-lichid), 2005
7. Thomas G. Mezger, „The Rheology Handbook: For users of rotational and oscillatory rheometers”, 2nd Edition, Ed.Vincentz Network (Coatings Compendia), 2006
8. M. Lungu, C. Ibănescu, „Proprietăţi reologice ale sistemelor polimere. Teorie şi aplicaţii”, Ed. Performantica, Iaşi, 2008
9. M. Mateescu, „Reologia alimentului”, Ed. Eurostampa, Timişoara, 2008
10. M. Bercea, „Reologia polimerilor. Ecuaţiile mediului continuu deformabil”, Vol. I, şi „Reologia polimerilor. Comportarea viscoelastică a polimerilor”, Vol. II, Ed. Tehnopress, Iaşi, 2009
11. C. Ibănescu, „Reologia sistemelor polimerice multifazice”, Suport de curs, Iaşi, 2013
12. A. Miclăuş (Ghirişan), V. Pode, „Cazuri particulare de curgere a fluidelor ideale şi reale. Elemente de reologie”, Casa Cărţii de Ştiinţă, Cluj-Napoca, 2018
13. A. Miclăuş (Ghirişan), „Rheology of disperse Systems”, Curs Power-Point

8.2. Seminar	Teaching methods	Remarks
8.2.1. Viscosity. Influence of thermodynamic parameters on viscosity of liquid systems. Fitting functions for temperature-dependent viscosity curves. Determination of activation energy.	Problems Discussions Analysis and interpretation	2 hours at 2 weeks
8.2.2. Shear stress and shear rate. Calculation of shear rates for technical processes.	Problems Discussions Analysis and interpretation	2 hours at 2 weeks
8.2.3. Mathematical models (functions) for flow and viscosity curves. Numerical application.	Problems Discussions Analysis and interpretation	2 hours at 2 weeks
8.2.4. Laminar flow in circular tubes for Non-Newtonian fluids. Determination of velocity, flow rate and pressure drop. Numerical application.	Problems Discussions Analysis and interpretation	2 hours at 2 weeks
8.2.5. Sedimentation of particles in Non-Newtonian fluids. Determination of settling velocity. Hindered settling. Numerical application.	Problems Discussions Analysis and interpretation	2 hours at 2 weeks
8.2.6. Motion of bubbles and drops. Numerical application.	Problems Discussions Analysis and interpretation	2 hours at 2 weeks
8.2.7. Flow through packed beds of particles (porous media). Numerical application.	Problems Discussions Analysis and interpretation	2 hours at 2 weeks
8.3. Laboratory		

8.3.1. Rheometry. Presentation of some viscometers and rheometers. Methods used for viscosity determination.	Discussions	2 hours at 2 weeks
8.3.2. Experimental determination of fluids viscosity using different types of viscometers (Hoeppler, Visco-Star, Brookfield).	Experimental tests Discussions Analysis and interpretation	2 hours at 2 weeks
8.3.3. Experimental measurements for different Newtonian and Non-Newtonian fluids using the rotational rheometer Rheotest II at constant temperature. Interpretation of rheological behavior using specific curves.	Experimental tests Discussions Analysis and interpretation	2 hours at 2 weeks
8.3.4. Determination of specific parameters and interpretation of different mathematical models applied to tested fluids.	Discussions Analysis and Interpretation	2 hours at 2 weeks
8.3.5. Experimental measurements for some solutions, emulsions, suspensions, pastes etc., at different thermal conditions.	Experimental tests Discussions	2 hours at 2 weeks
8.3.6. Determination of specific parameters and interpretation of activation energy obtained for tested systems.	Discussions Analysis and Interpretation	2 hours at 2 weeks
8.3.7. Rheological behavior of viscoelastic systems. Interpretation of some results obtained by oscillatory tests.	Problems Discussions	2 hours at 2 weeks

Bibliography

1. R.P. Chhabra, J. F. Richardson, „Non-Newtonian Flow in the process Industries. Fundamentals and Engineering Applications", Ed. Butterworth Heinemann, 1999
2. N. Teodorescu, **„**Reologie Aplicată**"**, Ed. Matrix Rom, Bucureşti, 2004
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5. M. Lungu, C. Ibănescu, „Proprietăţi reologice ale sistemelor polimere. Teorie şi aplicaţii", Ed. Performantica, Iaşi, 2008
6. M. Mateescu, „Reologia alimentului", Ed. Eurostampa, Timişoara, 2008
7. A. Miclăuş (Ghirişan), V. Pode, „Cazuri particulare de curgere a fluidelor ideale şi reale. Elemente de reologie", Casa Cărţii de Ştiinţă, Cluj-Napoca, 2018
8. A. Miclăuş (Ghirişan), „Rheology of disperse Systems", Curs Power-Point

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

- To establish the formative content of the course and laboratory work teaching and research personal from chemistry and chemical engineering departments from our faculty and from other universities have been invited.
- By assimilating the theoretical and methodological concepts and by approaching the practical aspects included in the *Rheology of disperse systems* discipline, the students acquire consistent knowledge in accordance with the competences of the Diploma Supplement and qualifications in the ANC

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	The capacity to understand the relevance of Rheology in Materials Science and Engineering and to apply the knowledge gained in solving real-world engineering problems.	The presence to exam depends on participation to the laboratory work and on the quality of reports.	60 %
	The ability to establish and to choose the models proper to the studied properties of materials, applying the correct research methods.		
10.5 Seminar/Laboratory	Capacity to analyze the theoretical and experimental models proper to describe the rheological behavior of materials in real applications.	The reports of the lab work will be done no later than the last week of the teaching activity. Students will be evaluated during the semester (at seminar and laboratory), in order to verify the individual interest, correctness of learning and knowledge gained.	40 %
	The activity during the lab work and the quality of reports.		
10.6 Minimum performance standards			
• 6 (six) in lab and examination according to the standard.			

Date
10.04.2024

Signature of course coordinator
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Signature of seminar coordinator
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Date of approval

22.04.2024

Signature of the head of department
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