

SYLLABUS

1. Information regarding the programme

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| 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' Degree |

2. Information regarding the discipline

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| 2.1 Name of the discipline | Rheology of disperse systems - CMX7312 | | | | | | |
| 2.2 Course coordinator | Conf. Adina GHIRIŞAN | | | | | | |
| 2.3 Seminar coordinator | Conf. Adina GHIRIŞAN | | | | | | |
| 2.4 Year of study | I | 2.5 Semester | 1 | 2.6. Type of evaluation | C | 2.7 Type of discipline | Op |

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

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|---|-----|--------------------|----|------------------------|-----|
| 3.1 Hours per week | 3 | Of which: 3.2 curs | 2 | 3.3 seminar/laboratory | 1 |
| 3.4 Total hours in the curriculum | 42 | Of which: 3.5 curs | 28 | 3.6 seminar/laboratory | 14 |
| Time allotment: | | | | | ore |
| Learning using manual, course support, bibliography, course notes | | | | | 36 |
| Additional documentation (in libraries, on electronic platforms, field documentation) | | | | | 32 |
| Preparation for seminars/labs, homework, papers, portfolios and essays | | | | | 32 |
| Tutorship | | | | | 4 |
| Evaluations | | | | | 4 |
| Other activities: | | | | | |
| 3.7 Total individual study hours | 108 | | | | |
| 3.8 Total hours per semester | 150 | | | | |
| 3.9 Number of ECTS credits | 6 | | | | |

4. Prerequisites (if necessary)

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| 4.1. curriculum | <ul style="list-style-type: none"> • Not necessary |
| 4.2. competencies | <ul style="list-style-type: none"> • Not necessary |

5. Conditions (if necessary)

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| 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 | <ul style="list-style-type: none"> • 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

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| Professional competencies | <p>Development of processes, machines and equipment specific to the process engineering by promoting new solutions to improve processes, optimal operation and control</p> <ul style="list-style-type: none"> • 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 | <ul style="list-style-type: none"> • 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)

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| 7.1 General objective | <ul style="list-style-type: none"> • 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 | <ul style="list-style-type: none"> • 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 |
|---|---------------------|---------------------|
| <p>Introduction. Fundamental concepts of rheology. Specific deformation, shear stress, shear rate. Flow behavior and viscosity. Elasticity.</p> | Interactive lecture | 1 lecture, 2 hours |
| <p>Systems with uniform properties Linear rheological behavior of fluids with uniform properties (Newton's fluid, Hook's solid and St. Vanant's plastic). Model functions for systems with ideal behavior.</p> | Interactive lecture | 1 lecture, 2 hours |
| <p>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. Yield point. Determination of the yield point.</p> | Interactive lecture | 2 lectures, 4 hours |
| <p>Viscous fluids with non-Newtonian time-dependent</p> | Interactive lecture | 2 lectures, 4 hours |

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|---|---------------------|---------------------|
| <p>behavior Time-dependent fluid flow behavior (thixotropic and rheopexic fluids). Rheological model functions, specific flow curves and viscosity functions. Structural decomposition and regeneration. Test methods for investigating thixotropy and rheopexy.</p> | | |
| <p>Materials with multiple properties Viscoelastic behavior. Basic principles. Theoretical and mechanical models: Maxwell, Voigt-Kelvin, Lethersich, Zener. Examples of the behavior of viscoelastic liquids and solids in practice.</p> | Interactive lecture | 2 lectures, 4 hours |
| <p>Rheology of liquid systems Rheology behavior of solutions, colloids, emulsions, suspensions and pastes: influence of solid concentration, shape, size and distribution of disperse phase, influence of mechanical and hydrodynamic effects on the rheological behavior. Electro-viscous effect. Analysis methods.</p> | Interactive lecture | 3 lectures, 6 hours |
| <p>Rheometry. Rheological measurements in static and dynamic regime. Rotational and oscillatory rheometers. Measuring systems and tests. Creep tests. Relaxation tests.</p> | Interactive lecture | 3 lectures, 6 hours |
| <p>Bibliography</p> <ol style="list-style-type: none"> 1. R. Z. Tudose, T. Volintiru, N. Asandei, M. Lungu, E. Merică și Gh. Ivan, „Reologia compușilor macromoleculari, I. Introducere în reologie”, Ed. Tehnică, București, 1982 2. R. Z. Tudose, T. Volintiru, N. Asandei, M. Lungu, E. Merică și Gh. Ivan, „Reologia compușilor macromoleculari, II. Reologia stării lichide”, Ed. Tehnică, București, 1984 3. R. Z. Tudose, T. Volintiru, N. Asandei, M. Lungu, E. Merică și Gh. Ivan, „Reologia compușilor macromoleculari, III. Reologia stării solide”, Ed. Tehnică, București, 1987 4. R.P. Chhabra, J. F. Richardson, „Non-Newtonian Flow in the process Industries. Fundamentals and Engineering Applications”, Ed. Butterworth Heinemann, 1999 5. R. Z. Tudose, „Ingineria proceselor fizice din industria chimică”, Ed. Academiei Române, v.I Fenomene de transfer, 2000 6. N. Teodorescu, „Reologie Aplicată”, Ed. Matrix Rom, București, 2004 7. Adina Lucreția Ghirișan, „Separarea fizico-mecanică a sistemelor eterogene solid-lichid”, Ed. Casa Cărții de Știință, Cluj-Napoca, (subcap. Comportarea reologică a sistemelor eterogene solid-lichid), 2005 8. Thomas G. Mezger, „The Rheology Handbook: For users of rotational and oscillatory rheometers”, 2nd Edition, Ed. Vincentz Network (Coatings Compendia), 2006 9. M. Lungu, C. Ibănescu, „Proprietăți reologice ale sistemelor polimere. Teorie și aplicații”, Ed. Performantica, Iași, 2008 10. Bercea, M., „Reologia polimerilor. Comportarea viscoelastică a polimerilor”, Vol. II, Ed. Tehnopress, Iași, 2009 | | |
| 8.2 Seminars / laboratory work | Teaching methods | Remarks |
| Viscosity. Influence of thermodynamic parameters on | Problems | 2 hours |

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| viscosity of liquid systems. Fitting functions for temperature-dependent viscosity curves. Determination of activation energy for the fluids' flow. | Discussions Analysis | |
| Experimental determination of fluids viscosity using different types of rotational rheometers (Hoeppler, Visco-Star, Brookfield). | Experimental tests Discussions Interpretation | 2 hours |
| Determination of specific flow curves and viscosity curves for different Newtonian and non-Newtonian fluids by the rotational rheometer Rheotest 2. | Experimental tests Discussions Interpretation | 4 hours |
| Rheological behavior of slips and ceramic pastes. Influence of solid concentration. | Problems Discussions | 2 hours |
| Rheological behavior of viscoelastic systems. Interpretation of oscillatory tests. | Problems Discussions | 2 hours |
| Colloquium | | |
| Bibliography <ol style="list-style-type: none"> 1. N. Teodorescu, „Reologie Aplicată,, Ed. Matrix Rom, București, 2004 2. Adina Lucreția Ghirișan, „Separarea fizico-mecanică a sistemelor eterogene solid-lichid”, Ed. Casa Cărții de Știință, Cluj-Napoca, (subcap. Comportarea reologică a sistemelor eterogene solid-lichid), 2005 3. Thomas G. Mezger, „The Rheology Handbook: For users of rotational and oscillatory rheometers”, 2nd Edition, Ed. Vincentz Network (Coatings Compendia), 2006 4. M. Lungu, C. Ibănescu, „Proprietăți reologice ale sistemelor polimere. Teorie și aplicații”, Ed. Performantica, Iași, 2008 | | |

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.

10. Evaluation

| Type of activity | 10.1 Evaluation criteria | 10.2 Evaluation methods | 10.3 Share in the grade (%) |
|------------------|---|--|-----------------------------|
| 10.4 Course | <p>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.</p> <p>The ability to establish and to choose the models</p> | <p>The presence to colloquium depends on participation to the laboratory work and on the quality of reports.</p> <p>The exam is oral. It will assess thinking, reliability and replies argument.</p> | 60 % |

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| | proper to the studied properties of materials, applying the correct research methods. | | |
| 10.5 Seminar/lab activities | Capacity to analyze the theoretical and experimental models proper to describe the rheological behavior of bodies/fluids in real applications. | The reports of the lab work will be done no later than the last week of the teaching activity. | 40 % |
| | The activity during the lab work and the quality of reports. | | |
| 10.6 Minimum performance standards | | | |
| <ul style="list-style-type: none"> • 6 (six) in lab and examination according to the standard. | | | |

Date

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Signature of course coordinator

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Signature of seminar coordinator

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Date of approval

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Signature of the head of department

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