COURSE DESCRIPTION

Ceramics, binders and vitreous materials and advanced processing methods

Academic year 2026 - 2027

1. Programme-related data

1.1. Higher Education Institution	Babeş-Bolyai University
1.2. Faculty	Faculty of Chemistry and Chemical Engineering
1.3. Department	Department of Chemical Engineering
1.4. Field	Chemical Engineering
1.5. Level of study	Master
1.6. Degree programme / Qualification	Advanced Chemical Process Engineering
1.7. Form of education	Full-time education

2. Course-related data

2.1. Course title	**Ceramics, binders and vitreous materials and advanced processing methods**			Course code	**CME7134**
2.2. Course coordinator		Conf. dr. ing. Liliana BIZO			
2.3. Seminar coordinator		Conf. dr. ing. Liliana BIZO			
2.4. Year of study	II	2.5. Semester	3	2.6. Type of assessment	Exam
2.7. Course status		Compulsory		2.8. Course type	Specialisation subject

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

3.1. Number of hours per week	4	of which: 3.2. course	2	3.3. laboratory	2
3.4. Total of hours in the curriculum	56	of which: 3.5. course	28	3.6. laboratory	28
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					20
Additional research in the library, on subject-specific electronic platforms, and on-site					20
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					20
Tutoring (professional guidance)					6
Examinations					3
Other activities					-
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**69**	
3.8. Total hours per semester				**125**	
3.9. Number of credits				**5**	

4. Prerequisites (where applicable)

4.1. curriculum-related	-
4.2 skills-related	-

5. Specific conditions (where applicable)

5.1. course-related	• Students should switch off the mobile phones during courses and seminars. • Students should be present at the courses without any time delay.
5.2. laboratory-related	• The deadline for presenting the homework results will be agreed between the lab coordinator and the students. • No delay is accepted for the presentation of the homework results unless well-founded reasons are proven. • In case of presenting the homework with delay, the grade will be penalized by 0.5 points/day of delay.

	• Students should be present at the labs without any time delay.

6.1. Competencies resulting from the completion of the degree programme *(as referred to in the curriculum)*[1]

Professional competencies	
Competency code	**Competency**
CP1	Description, analysis and use of elaborate theories and concepts in the fields of chemistry and process advanced chemical engineering.
CP2	Technological design of processes, equipment and apparatus specific to process engineering for the improvement of performances of biochemical and chemical processes by using computer-assisted instruments (CAD) and principles of long-term development.
CP3	Development and use of mathematical models and simulators in process engineering for diagnosis of problems, analysis of optimum operating systems and control of (bio)chemical processes.
CP4	Development of processes, apparatus and equipment specific to process engineering by promoting new solutions for process intensification, optimum operation and control.
CP5	Identifying and defining a research theme in the field of chemical engineering process, elaboration and implementation of a plan for achieving the objectives proposed and valuing the scientific research results obtained.
CP6	Quality and resource management in process engineering by applying the systemic approach and the principles of long-term development.
Transversal competencies	
Competency code	**Competency**
CT1	Independent execution of complex professional assignments and autonomous development of project-research activities by using computer-assisted techniques and by observing the norms of professional ethics and moral conduct.
CT2	Planning, monitoring, and assuming the duties of a subordinate professional group. Demonstrating the capacity of coordination, analytical thinking, adaptability and flexibility, collaboration with team members.
CT3	Self-assessment of professional performances and determining the continuous training needs, permanent information and documentation in the field of activity and related areas, according to the needs of the labour market.

6.2. Learning outcomes relevant to the degree programme (as referred to in the curriculum)[2]

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
CP2 **CT1**	1. Performing a critical analysis based on CAD tools, to identify possible solutions to complex problems of designing equipment and plants in a chemical process	1. Development of integrated projects, based on CAD tools, for the creative development of the design of devices, equipment and plants in the chemical process industries
CP6 **CT2**	2. Knowledge of concepts and theories specific to resources and quality management for process engineering, in the context of sustainable development	2. Use of qualitative and quantitative methods for assessing risk factors, operational safety and management, in the development of new projects for resources and quality management

[1] The professional and/or transversal skills targeted by the subject for which the course description is prepared will be copied from the curriculum of the degree programme. For each competency, the complete entry, including the competency code, will be copied with the exact wording that appears in the curriculum, without any changes. If no competency is copied from either of the two categories, the row corresponding to that category is deleted from the table.

[2] The learning outcomes relevant for the degree programme and targeted by the subject for which the course description is prepared will be listed. The entries, copied without any changes from the Curriculum by subject type (Core Subject/Specialisation Subject/Complementary Subject), are listed under the corresponding competency.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. The student knows, defines and identifies the fundamental and applied concepts for the realisation of advanced materials using various processing methods.
2. The student has the necessary knowledge to carry out an extensive bibliographic study related to the chosen research topic, organize and synthesize data with the acquisition of domain-specific terminology, knowledge of general and specific research methods.
3. The student understands and uses specialized knowledge to establish the research strategy, conduct experiments and interpret the results.
4. The student knows and uses the conceptual and methodological research apparatus for new theoretical approaches in the synthesis and processing of materials.
5. The student knows, selects and uses adequately the research methods for a correct interpretation of the results and the formulation of pertinent conclusions.
Specific academic skills
1. The student has the ability to carry out research-design activities in an autonomous manner, using specific equipment (including computer-assisted), in compliance with the norms of professional ethics and moral conduct.
2. The student has the ability to self-assess his/her own professional performance and the needs for continuous professional improvement based on updating permanent knowledge (Lifelong Learning) related to his/her field of activity and to align his/her personal development with current trends and the constantly changing requirements of the labor market.
3. The student has the ability to communicate his/her own points of view, in a clear and concise manner, using means of communication based on conventional and unconventional information technology tools.

8. Contents

8.1. Course	**Teaching and learning methods**	**Remarks[3]**
8.1.1. High reliability ceramics. Processing methods, densification concepts, colloidal powder processing. Silicon nitride powders. Powder synthesis and characterization. Powder dispersion. Surface properties. Powder sintering. Ceramic properties.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.2. Stabilized zirconia ceramics. Wet processing. Microstructure. Forming. Thermal treatment. Properties. Structural ceramics. Thin films- deposition methods.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.3. Electronic ceramics. Processing. Wet Forming. Slip Casting. Thermal treatment. Properties. Microwave processing of ceramics.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.4. Ceramic composites. Microstructure and processing. Sintering and Hot Forming. Reaction Processing. Melt Processing Methods. Chemical Vapor Deposition.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.5. Oxide-salt-water binders. A. Binders in system MgO-$MgCl_2$($MgSO_4$)-H_2O. Phase equilibrium, compositions, characteristics. B. Binders analogous to Sorel cement. Alkaline-earth and with other cationic elements binding systems.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.6. Oxide-acid-water binders. A. Phosphate binders. Phase equilibria.	Lecture giving, explanation, conversation, exemplification, debate	2h

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

Reaction products. Hardening mechanism. B. Biocements. Types (calcium-phosphate, zinc-phosphate dental cement, magnesite-phosphate and silicate-phosphate).		
8.1.7. Binders for high temperatures (refractories). Aluminate-phosphate, magnesite-phosphate and chromo-phosphate binders, etc.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.8. Oxidic materials with vitreous structure. Characterization of the vitreous structure. Correlation of composition-structure-properties-applications.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.9. Choosing the preparation process of products according to the shape and applications.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.10. Technical glasses: electrotechnical glasses, Vycor glasses, semiconducting glasses, isolating glasses.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.11. Technical glasses: optical and selective absorption glasses. The condition imposed to optical glasses, optical and selective absorption glasses, photosensitive glasses, optical fibers.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.12. Glass-ceramic materials: oxidic systems used to obtain glass-ceramic materials. Criteria for determining compositions for glass-ceramics with predefined properties.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.13. Glasses used in nuclear technology.	Lecture giving, explanation, conversation, exemplification, debate	2h
8.1.14. Vitreous biomaterials. Biological glasses with controlled corrosion, radio therapy glasses, glass-ceramics for hyperthermia.	Lecture giving, explanation, conversation, exemplification, debate	2h

Bibliography

1. K. Muduli, R. Thanigaivelan, P. K. Krishnan, S. K. Tamang, New Materials, Processing and Manufacturability, Scrivener Publishing LLC, Wiley, 2024, ISBN 978-1-394-21254-5 (ePDF).
2. R. Riedel, I.-Wei Chen (Eds.), Ceramics Science and Technology, Wiley-VCH, 2008, ISBN: 978-3-527-63196-4 (ePDF).
3. J. Heinrich, F. Aldinger (Eds.), Ceramic Materials and Components for Engines, Wiley-VCH, 2001, ISBN: 3-527-30416-9 (ePDF).
4. I. Teoreanu, Bazele tehnologiei lianţilor anorganici, Editura Didactica şi Pedagogica, Bucureşti, 1993, Biblioteca Centrală Universitară.
5. P. Balta, Tehnologia sticlei, Editura Didactică şi Pedagogică, Bucuresti, 1984, Biblioteca Centrală Universitară, Biblioteca Facultăţii de Chimie.
6. F. Goga, Tehnici de analiză a materialelor oxidice, Presa Universitară Clujeană, 2006, Biblioteca Facultăţii de Chimie, ISBN: (13)978-973-610-495-4.
7. PowerPoint presentation, 2026.

8.2. Laboratory	**Teaching and learning methods**	**Remarks**
8.2.1. Presentation and discussion of experimental works. Work safety rules.	Explanation, conversation, exemplification	2h
8.2.2. Colloidal powders processing.	Experiment, conversation, learning by discovery, team working	2h
8.2.3. Stabilized zirconia and thin films deposition methods.	Experiment, conversation, learning by discovery, team working	2h
8.2.4. Microwave processing of electronic ceramics.	Experiment, conversation, learning by discovery, team working	2h
8.2.5. Sintering and hot pressing of ceramic composites.	Experiment, conversation, learning by discovery, team working	2h

8.2.6. Physical and chemical deposition of thin films.	Experiment, conversation, learning by discovery, team working	2h
8.2.7. Combustion method for binders obtaining.	Experiment, conversation, learning by discovery, team working	2h
8.2.8. Theoretical method for properties prediction of vitreous materials.	Experiment, conversation, learning by discovery, team working	2h
8.2.9. Composition and raw materials recipe design for special glasses.	Conversation method, learning by discovery, individual learning, team working	2h
8.2.10. Study of the melting processes in borate-silicate glasses.	Experiment, conversation, learning by discovery, team working	2h
8.2.11. Synthesis of low melting glasses. Synthesis and thermal analysis of a glass-ceramic.	Experiment, conversation, learning by discovery, team working	2h
8.2.12. Synthesis of colored glasses. Color characterization by dominant wavelength determination.	Experiment, conversation, learning by discovery, team working	2h
8.2.13. Recovery of lab works/ Applications	Experiment, conversation, learning by discovery, team working	2h
8.2.14. Evaluation of laboratory works.	Test	2h

Bibliography
1. L. Gagea, CERAMICĂ de laborator. Lucrări şi probleme, Casa Cărţii de Ştiinţă, Cluj-Napoca, 2003, BCU, Biblioteca Facultăţii de Chimie, Biblioteca Departamentului de Inginerie Chimică.
2. F. Goga, Tehnici de analiză a materialelor oxidice, Editura Presa Universitară Clujeană, 2006, Biblioteca Facultăţii de Chimie.

9. Evaluation

Type of activity	9.1 Evaluation criteria[4]	9.2 Evaluation methods[5]	9.3 Percentage in the final grade
9.4. Course	The correctness of answers, assimilation and understanding of the issues treated in class The ability to particulate the overall phenomena to a specific product	Viva voce assesment Access to examination is conditioned by the presentation of the prepared homework results. Intentional fraud in the exam is punishable by elimination from the exam. The fraud is punished by expulsion according to the ECTS regulations of UBB.	70%
9.5. Laboratory	The correctness of answers, assimilation and understanding of the issues treated to the laboratory The quality of the prepared laboratory reports The activity carried out in the lab	Laboratory works corresponding to lab activities are delivered in the last week of teaching activity. Laboratory test will take place in the last week of teaching activity.	30%

9.6 Minimum standard for passing

- Minimum condition for exam promoting: 5(five) grade at lab test and 5(five) grade at oral assesment.
- Knowledge of basic concepts, composition and microstructure of an ceramic, binder and vitreous product, main technological parameters, elaboration of a technologic flow for an advanced material with main stages,

[4] 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.

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

correlation of processing methods, properties and applications (Processing-Structure-Properties-Performance relationship).

10. SDG labels (Sustainable Development Goals)[6]

	○ Sustainable Development Generic Label							
								
○	○	○	○	○	○	○	○	◉
								No label applies
○	○	○	○	○	○	○	○	○

Date of entry:
09.04.2026

Signature of course coordinator

Conf. dr. ing. Liliana BIZO

Signature of seminar coordinator

Conf. dr. ing. Liliana BIZO

Date of approval in the department:
21.04.2026

Signature of the head of department

Prof. habil. dr. ing. Graziella Liana TURDEAN

[6] 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."*