



UNIVERSITATEA BABEŞ-BOLYAI
BABEŞ-BOLYAI TUDOMÁNYEGYETEM
BABEŞ-BOLYAI UNIVERSITAT
BABEŞ-BOLYAI UNIVERSITY
TRADITIO ET EXCELLENTIA

Tradiție și Excelență prin
Cultură - Știință - Inovație din 1581



Facultatea de Chimie și Inginerie Chimică

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COURSE DESCRIPTION

Advanced Chemical Engineering

University year 2026-2027

1. Information regarding the programme

1.1. Higher education institution	Babeş-Bolyai University
1.2. Faculty	Faculty of Chemistry and Chemical Engineering
1.3. Department	Doctoral School of Chemical Engineering
1.4. Field	Chemical Engineering
1.5. Level of study	Doctorate
1.6. Degree programme / Qualification	Chemical Engineering/Doctor
1.7. Form of education	Full-time education

2. Information regarding the discipline

2.1. Course title	Advanced Chemical Engineering			Course code	SDIC8111
2.2. Course coordinator:	Prof. PhD Eng. Calin-Cristian Cormos				
2.3. Seminar coordinator:	Prof. PhD Eng. Calin-Cristian Cormos				
2.4. Year of study	I	2.5. Semester	1	2.6. Type of assessment	Exam
2.7. Course status	Compulsory			4.8. 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	1	3.3 seminar/laboratory	2
3.4. Total hours in the curriculum	36	of which: 3.5 course	12	3.6 seminar/laborator	24
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					60
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					48
Tutoring (professional guidance)					43
Examinations					3
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	Not the case
4.2. skills-related	Not the case



5. Specific conditions (where applicable)

5.1. course-related	<ul style="list-style-type: none"> Students will attend the class with their mobile phones closed The delay will not be accepted
5.2. seminar/laboratory-related	<ul style="list-style-type: none"> Students will attend the seminar with their mobile phones closed The final report will be handed in at the latest in the first week of session For late delivery is penalized with 0.5 points / day It is forbidden to enter the seminar room with food

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

Professional competencies	
Competency code	Competency
PC1	Advanced knowledge and original knowledge generation skills in the field of chemical engineering for technologies, processes, production of new substances and materials
PC2	Capacity to design complex chemical processes and innovative materials across the entire laboratory, pilot and industrial scale chain
PC3	Capacity to design original technical solutions for the optimization and advanced control of chemical processes and technologies/methodologies for the production of materials with new properties
PC4	Digital competences to use advanced IT tools for the data analysis and the development of high-performance mathematical models, as well as for taking sustainable development decisions
PC5	Competences in developing technical, economic and environmental impact analyses for chemical processes and the production of new materials, in order to design innovative and sustainable solutions regarding the reduction of energy consumption, quality management, efficient use of raw materials and resource recovery
Transversal competencies	
Competency code	Competency
TC1	Ability to work autonomously in order to design, build and implement on one's own initiative the actions of the developed research plans
TC2	The ability to scientifically and professionally coordinate research teams within projects that aim to develop complex chemical products and innovative materials, as well as those that are multidisciplinary or that integrate research from several fields
TC3	Ability to act responsibly to achieve research objectives, assuming complex tasks to accomplish them
TC4	Ability to comply with ethical and academic-professional integrity norms to respect good conduct in scientific research
TC5	Ability to lead or participate in national or international research teams within research projects or to the transfer of research results to industry or society
TC6	The ability to use professional communication methods and disseminate original research results through publications, conferences, scientific communications and research reports

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.



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
PC1	1. The doctoral student acquires and recognizes advanced aspects of transfer phenomena (mass, heat, momentum), thermodynamics, kinetics, chemical/biochemical reaction and materials engineering, automatic control, process optimization, aspects at the border of their interference with scientific research	1. The doctoral student uses advanced knowledge to identify and formulate original research topics in order to develop innovative solutions and generate new knowledge
PC2 PC3 PC4	2. The doctoral student applies the principles and theoretical concepts of transfer phenomena, thermodynamics, kinetics, chemical reaction engineering, materials science, automatic control and process optimization to substantiate the original solution to the research topic	2. The doctoral student proposes an original research project, applies theoretical principles and concepts for the design of experimental or computational research methodology, for carrying out research activity on the chosen topic, involving process intensification methodologies, thermal integration, sustainable development, advanced mathematical modelling tools, experimental design, data analysis and analysis of the structure-property relationship of materials
PC5	3. The doctoral student critically analyses and compares the theoretical solution variants obtained for the research topic	3. The doctoral student analyses the performance of solution options on the research topic of innovative processes or materials, considering the aspects of technical, economic and environmental performance, including that of scaling up (from laboratory, pilot to industrial scale)
PC1 PC5	4. The doctoral student creates and conceptualizes the innovative solution obtained through research	4. The doctoral student creates and proposes innovative solutions to solve problems in chemical engineering processes or materials, highlighting the most efficient solution that integrates quality, cost and sustainable development requirements
TC1 TC3	5. The doctoral student acquires the principles and methods of working under conditions of autonomy and responsibility	5. The doctoral student implements the research project with independent initiatives and decisions, assuming the consequences and being responsible for his own activity
TC2	6. The doctoral student acquires and recognizes the concepts, principles and methods of management and teamwork	6. The doctoral student coordinates or supervises research teams, manages projects and resources

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.



<p>TC5 TC6</p>	<p>7. The doctoral student acquires methods of communication and dissemination of the obtained research results</p>	<p>7. The doctoral student develops research reports, publishes the thesis and scientific articles in journals, participates in scientific events, consortia, transfers research results to industry and the social environment, both at national and international level</p>
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7. Subject-specific learning outcomes

Knowledge and comprehension	
1. Doctoral student knows the main elements used in the design and operation of modern production systems.	
2. Doctoral student understands how to apply modern evaluation techniques for sustainable development.	
3. Doctoral student applies adequate working tools for chemical process design.	
4. Doctoral student makes the difference between various performance indicators used for process analysis.	
Specific academic skills	
1. Doctoral student identifies the main research and development directions of chemical engineering for sustainable development.	
2. Doctoral student makes the difference between integration and intensification methods applied in design and operation of chemical production systems.	
3. Doctoral student applies modern paradigms of chemical engineering to solve key problems of industrial sector.	

8. Content

8.1 Course	Teaching and learning methods	Remarks ³
8.1.1. Introductory notions related to chemical and process engineering. Types of chemicals (heavy chemicals, light chemical functional chemicals), differences in the approach to their design processes. Current challenges of chemical and process engineering. Historical and current paradigms in chemical engineering. Sustainable development of chemical processes. Sustainable development of chemical processes.	<p>Presentation, discussion, case studies, exercises</p>	
8.1.2. Use of modern design and optimization techniques in chemical engineering. Applying computer-aided design techniques, mathematical modelling, simulation and optimization of chemical processes. Validation of mathematical models. Techno-economic and environmental evaluation (including life cycle analysis) of industrial systems		
8.1.3. Modern solutions for the intensification of chemical processes in order to develop sustainable solutions with improved technical		

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



and economic indicators and reduced impact on the environment. Exemplification for the reactive distillation process for the synthesis of ethyl acetate.		
8.1.4. Modern solutions for the integration of mass and energy flows in order to improve the technical-economic and environmental indicators of the processes. Example for some representative industrial processes e.g. synthesis of ammonia, methanol, biodiesel, etc.		
8.1.5. Modern energy conversion systems with a stage for capturing, using or storing CO ₂ . Advantages and disadvantages of CO ₂ capture, use and storage (CCUS) technologies.		
8.1.6. Current and future directions of development in chemical and process engineering to solve the major problems of society. Sustainable development, reducing the impact on the environment, limiting the consumption of non-renewable resources and the use of renewable ones, etc.		
Bibliography: 1. R. Smith, Chemical process: Design and integration, John Wiley / Sons, 2nd edition, 2016. 2. W. D. Seider, J. D. Seader, D. R. Lewin, Product & process design principles, John Wiley / Sons, 2004. 3. A. Dimian, Integrated design and simulation of chemical processes, Elsevier, 2003. 4. C.C. Cormos, Decarbonizarea combustibililor fosili solizi prin gazeificare, Presa Universitara Clujana, 2008.		
8.2 Seminar / laboratory	Teaching and learning methods	Remarks
8.2.1. Introduction of industrial processes in computer-aided design elements. Process simulators, generation and evaluation of process alternatives, mass and energy balances of processes, technical-economic and environmental evaluation, selection of the optimal variant.	Presentation, discussion, exercises	
8.2.2. Case study for process intensification: Reactive distillation applied for the synthesis of ethyl acetate and biodiesel. Generating the basic configuration and evaluating the possibilities for its optimization. Technical-economic and environmental assessment.		
8.2.3. Case study for energy integration (by pinch analysis) of chemical processes: ammonia synthesis by methane gas reformation. Generating the basic configuration and possibilities for its optimization. Reducing the impact on the environment by applying CO ₂ capture technologies.		
8.2.4. Determining the minimum necessary heating and cooling of the technological process, temperature - enthalpy diagrams, grand composite curves. Calculating the capital		



and operating costs of the heat exchanger network, establishing the trade-off between capital and operating costs, choosing the minimum temperature difference between hot and cold flows.		
8.2.5. Integration of heat and power in an industrial installation. Modelling and simulation of energy conversion systems for fossil fuels: the case of the coal gasification process. Brayton and Rankin thermodynamic cycles. Simulation Heat Recovery Steam Generator (HRSG).		
8.2.6. Mathematical modelling and simulation of gasification of coal coupled with chemical installations. Case study: methanol synthesis. Poly-generation systems using the gasification process. Generating mass and energy balances for the analyzed process. Technical-economic and environmental assessment of the coal gasification process for methanol synthesis (including the CO ₂ capture stage) in order to develop sustainable solutions.		
<p>Bibliography:</p> <ol style="list-style-type: none"> 1. J.M. Douglas, Conceptual design of chemical processes, McGraw-Hill Book Company, New York, U.S.A, 1988. 2. R. Smith, Chemical process: Design and integration, John Wiley / Sons, 2nd edition, 2016. 3. W. D. Seider, J. D. Seader, D. R. Lewin, Product & process design principles, John Wiley / Sons, 2004. 4. A. Dimian, Integrated design and simulation of chemical processes, Elsevier, 2003. 5. C. Higman, M. Van der Burgt, Gasification, Burlington, Elsevier Science, 2003. 6. C.C. Cormos, Decarbonizarea combustibililor fosili solizi prin gazeificare, Presa Universitara Clujana, 2008. 		

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	Assessment of knowledge	Written exam	100%
	Assessment of knowledge	Ongoing tests	
9.5 Seminar/laboratory	Activity during seminars	Discussions, answers to questions	
	Assessment of knowledge	Written exam	
9.6 Minimum standard for passing			
<ul style="list-style-type: none"> • "Satisfactory" grade for the exam according to the scale. • Knowledge of introductory notions regarding current trends in the field of chemical and process engineering, aspects of integration and intensification of processes for the development of sustainable solutions. 			

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.



10. Labels ODD (Sustainable Development Goals)⁶

	Sustainable Development Generic Label							
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
								No label applies
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Date of entry:
22.01.2026

Signature of course coordinator
Prof. PhD Eng.Cormoș Călin Cristian

Signature of seminar coordinator
Prof. PhD Eng.Cormoș Călin Cristian

Date of approval in the doctoral school council:
30.01.2026

Signature of the doctoral school director
Prof. PhD Eng.Cristea Vasile Mircea

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."



COURSE DESCRIPTION

Methodology of research project development in chemical

Academic year 2025-2026

1. Programme-related data

1.1. Higher Education Institution	Babeș-Bolyai University
1.2. Faculty	Faculty of Chemistry and Chemical Engineering
1.3. Department	Chemical Engineering
1.4. Field	Chemical Engineering
1.5. Level of study	Doctorate
1.6. Degree programme / Qualification	Doctoral training/ PhD in Chemical Engineering
1.7. Form of education	Full-time education

2. Course-related data

2.1. Course title	Methodology of research project development in chemical			Course code	SDIC8112
2.2. Course coordinator	Prof. PhD. Eng. Reka BARABAS Prof. PhD. Ana-Maria CORMOȘ				
2.3. Seminar coordinator	Prof. PhD. Eng. Reka BARABAS Prof. PhD. Ana-Maria CORMOȘ				
2.4. Year of study	I	2.5. Semester	1	2.6. Type of assessment	Exam
2.7. Course status	Compulsory		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	1	3.3. seminar/ laboratory/ project	2
3.4. Total of hours in the curriculum	36	of which: 3.5. course	12	3.6. seminar/ laboratory	24
Time allocation for individual study (IS) and self-taught activities (ST)					hours
Learning from textbooks, course materials, bibliography, and notes (IS)					48
Additional research in the library, on subject-specific electronic platforms, and on-site					72
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays (greater than or equal to the total number of hours specified in the course calendar for evaluation tasks)					54
Tutoring (professional guidance)					36
Examinations					4
Other activities [i.e.: two-way communication with the course coordinator/tutor]					-
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	Not the case
4.2. skills-related	Not the case



5. Specific conditions (where applicable)

5.1. course-related	<ul style="list-style-type: none"> •Students will attend the class with their mobile phones closed •The delay will not be accepted
5.2. seminar/laboratory-related	<ul style="list-style-type: none"> •Students will attend the seminar with their mobile phones closed •Students attend seminar sessions with the theoretical knowledge necessary to discuss the topic.

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

Professional competencies	
Competency code	Competency
PC1	Advanced knowledge and original knowledge generation skills in the field of chemical engineering for technologies, processes, production of new substances and materials
PC3	Capacity to design original technical solutions for the optimization and advanced control of chemical processes and technologies/methodologies for the production of materials with new properties
PC5	Competences in developing technical, economic and environmental impact analyses for chemical processes and the production of new materials, in order to design innovative and sustainable solutions regarding the reduction of energy consumption, quality management, efficient use of raw materials and resource recovery
Transversal competencies	
Competency code	Competency
TC1	Ability to work autonomously in order to design, build and implement on one's own initiative the actions of the developed research plans
TC2	The ability to scientifically and professionally coordinate research teams within projects that aim to develop complex chemical products and innovative materials, as well as those that are multidisciplinary or that integrate research from several fields
TC3	Ability to act responsibly to achieve research objectives, assuming complex tasks to accomplish them
TC4	Ability to comply with ethical and academic-professional integrity norms to respect good conduct in scientific research
TC5	Ability to lead or participate in national or international research teams within research projects or to the transfer of research results to industry or society
TC6	The ability to use professional communication methods and disseminate original research results through publications, conferences, scientific communications and research reports

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

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.



PC5	1. The doctoral student critically analyses and compares the theoretical solution variants obtained for the research topic	1. The doctoral student analyses the performance of solution options on the research topic of innovative processes or materials, considering the aspects of technical, economic and environmental performance, including that of scaling up (from laboratory, pilot to industrial scale)
PC4 PC5	2. The doctoral student evaluates and argues the validity of the theories used to obtain solutions to the research topic	2. The doctoral student evaluates the results of original solutions to the research topic using the analysed performance criteria and appropriate digital tools
PC1 PC5	3. The doctoral student creates and conceptualizes the innovative solution obtained through research	3. The doctoral student creates and proposes innovative solutions to solve problems in chemical engineering processes or materials, highlighting the most efficient solution that integrates quality, cost and sustainable development requirements
TC1 TC3	4. The doctoral student acquires the principles and methods of working under conditions of autonomy and responsibility	4. The doctoral student implements the research project with independent initiatives and decisions, assuming the consequences and being responsible for his own activity
TC2	5. The doctoral student acquires and recognizes the concepts, principles and methods of management and teamwork	5. The doctoral student coordinates or supervises research teams, manages projects and resources
TC4	6. The doctoral student acquires the principles of ethics and academic-professional integrity	6. The doctoral student applies the norms of ethics and academic-professional integrity in all phases of development of the research project
TC5 TC6	7. The doctoral student acquires methods of communication and dissemination of the obtained research results	7. The doctoral student develops research reports, publishes the thesis and scientific articles in journals, participates in scientific events, consortia, transfers research results to industry and the social environment, both at national and international level

7. Subject-specific learning outcomes

Knowledge and comprehension
1. The student knows: Basic notions regarding research methods and techniques appropriate to the research objective, notions related to innovation and those related to patenting and intellectual property rights.
2. The student understands the need for basic concepts related to the preparation and implementation of a research project
3. The student knows and understands the need to protect intellectual property and the notion of innovation.
Specific academic skills
1. The student is able to write research projects and prepare the necessary documentation for the registration of national and international patents.
2. The student has the ability to work independently, responsibly and in a team to develop research projects and documentation related to obtaining national and international patents.



8. Contents

8.1. Course	Teaching and learning methods	Remarks ³
8.1.1. Project management - role and purpose. Objectives and building the master plan. Resource planning. Identifying the resources required for the project.	Presentation, discussion, case studies, exercises	2 h
8.1.2. Activity plan: definition of activities, identification of specific actions to be carried out Sequence of activities; Attracting funds. Making the budget.	Presentation, discussion, case studies, exercises	2 h
8.1.3. Programme/project implementation; Analysis of the successful implementation of activities. SWOT analysis; Relationship with funders/ beneficiaries.	Presentation, discussion, case studies, exercises	2 h
8.1.4. Intellectual property rights. Introductory concepts.	Presentation, discussion, case studies, exercises	2 h
8.1.5. National patents. OSIM.	Presentation, discussion, case studies, exercises	2 h
8.1.6. International patents. Drafting patent applications.	Presentation, discussion, case studies, exercises	2 h
Bibliography 1.D. Oprea. Project management: theory and practice (in Romanian), Ed. Sedcom Libris, Iași, 2001. 2.N. Postăvaru, Projects management, Ed. Matrix, Bucuresti, 2002. 3.T. Mochal, J. Mochal, Lessons of project management, Ed. CODECS, București, 2006. 4.Claudiu Marian Bunăiasu, Elaboration and Management of the projects, Ed. Universitară, Bucuresti, 2012. 5.Alexandru Cristian Strenc , Bucura Ionescu , Gheorghe Gheorghiu, Patent law., Editura Universul Juridic, 2019		
8.2. Seminar/ laboratory	Teaching and learning methods	Remarks
8.2.1. The use of databases and scientist literature on the research topic.	Presentation, case studies, discussion, exercises	4 h
8.2.2. Development of research project.	Presentation, case studies, discussion, exercises	4 h
8.2.3. Project management.	Presentation, case studies, discussion, exercises	4 h
8.2.4. National and international patent documentation	Presentation, case studies, discussion, exercises	4 h
8.2.5. Making national patent applications	Presentation, case studies, discussion, exercises	4 h
8.2.6. Making patent claims	Presentation, case studies, discussion, exercises	4 h
Bibliography 1.D. Oprea. Project management: theory and practice, Ed. Sedcom Libris, Iași, 2001. 2.N. Postăvaru, Projects management, Ed. Matrix, Bucuresti, 2002. 3.T. Mochal, J. Mochal, Lessons of project management, Ed. CODECS, București, 2006. 4.Claudiu Marian Bunăiasu, Elaboration and Management of the projects, Ed. Universitară, Bucuresti, 2012. 5.Alexandru Cristian Strenc , Bucura Ionescu , Gheorghe Gheorghiu, Patent law., Editura Universul Juridic, 2019		

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



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	Assessment of knowledge	Development of research project.	80%
	Assessment of knowledge		
9.5. Seminar/ laboratory	Activity during seminars	Discussions, answers to questions	20%
	Assessment of knowledge		
9.6 Minimum standard for passing			
<ul style="list-style-type: none"> • "Satisfactory" grade for the exam according to the scale. • Knowledge of introductory notions regarding current trends in the field of project development. 			

10. SDG labels (Sustainable Development Goals)⁶

Eticheta generală pentru Dezvoltare durabilă								
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
								Nu se aplică nici o etichetă
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Date of entry:
22.01.2026

Signature of course coordinator
Prof. PhD. Eng. Reka Barabas
Prof. PhD. Ana-Maria Cormos

Signature of seminar coordinator
Prof. PhD. Eng. Reka Barabas
Prof. PhD. Ana-Maria Cormos

Date of approval in the doctoral school council:
30.01.2026

Signature of the doctoral school director
Prof. PhD Eng. Cristea Vasile-Mircea

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.

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."



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www.chem.ubbcluj.ro

COURSE DESCRIPTION

Ethics, professional deontology and intellectual property

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	University "Babes-Bolyai"
1.2. Faculty	Faculty of Chemistry and Chemical Engineering
1.3. Department	Doctoral School of Chemical Engineering
1.4. Field	Chemical Engineering
1.5. Level of study	PhD
1.6. Degree programme / Qualification	PhD/ PhD in Chemical Engineering
1.7. Form of education	Full-time education

2. Course-related data

2.1. Course title	Ethics, professional deontology and intellectual property	Course code	SDIC8113
2.2. Course coordinator	Prof. habil. dr. eng. Graziella Liana TURDEAN		
2.3. Seminar coordinator	Prof. habil. dr. eng. Graziella Liana TURDEAN		
2.4. Year of study	2.5. Semester	2.6. Type of assessment	Exam
2.7. Course status	Compulsory	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	1	3.3. seminar/ laboratory/ project	2
3.4. Total of hours in the curriculum	36	of which: 3.5. course	12	3.6. seminar/ laboratory	24
Time allocation for individual study (IS) and self-taught activities (ST)					hours
Learning from textbooks, course materials, bibliography, and notes (IS)					64
Additional research in the library, on subject-specific electronic platforms, and on-site					48
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					60
Tutoring (professional guidance)					40
Examinations					2
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	Not the case.
4.2 skills-related	Not the case.



5. Specific conditions (where applicable)

5.1. course-related	<ul style="list-style-type: none"> • Students will turn off their mobile phones during the course. • Students will be punctual to the course schedule; tardiness is not accepted.
5.2. seminar/laboratory-related	<ul style="list-style-type: none"> • Students will turn off their mobile phones during the seminar. • Students will present themselves at the seminar sessions having acquired the theoretical knowledge necessary to discuss the topic, as well as the necessary supplies (pocket calculators, pencils, erasers, rulers). • Food is prohibited in the seminar room.

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

Professional competencies	
Competency code	Competency
CP 1	Advanced knowledge and original knowledge generation skills in the field of chemical engineering for technologies, processes, and production of new substances and materials
CP2	Capacity to design complex chemical processes and innovative materials across the entire laboratory, pilot and industrial scale chain
CP3	Capacity to design original technical solutions for the optimisation and advanced control of chemical processes and technologies/methodologies for the production of materials with new properties
CP4	Digital competences to use advanced IT tools for data analysis and the development of high-performance mathematical models, as well as for taking sustainable development decisions
CP5	Competences in developing technical, economic and environmental impact analyses for chemical processes and the production of new materials, in order to design innovative and sustainable solutions regarding the reduction of energy consumption, quality management, efficient use of raw materials and resource recovery
Transversal competencies	
Competency code	Competency
CT1	Ability to work autonomously in order to design, build and implement on one's own initiative the actions of the developed research plans.
CT2	The ability to scientifically and professionally coordinate research teams within projects that aim to develop complex chemical products and innovative materials, as well as those that are multidisciplinary or that integrate research from several fields.
CT3	Ability to act responsibly to achieve research objectives, assuming complex tasks to accomplish them.
CT4	Ability to comply with ethical and academic-professional integrity norms to respect good conduct in scientific research.
CT5	Ability to lead or participate in national or international research teams within research projects or to transfer research results to industry or society.
CT6	The ability to use professional communication methods and disseminate original research results through publications, conferences, scientific communications and research reports.

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.



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
CT 4	9. The doctoral student acquires the principles of ethics and academic-professional integrity.	9. The doctoral student applies the norms of ethics and academic-professional integrity in all phases of development of the research project.
CT5 CT6	10. The doctoral student acquires methods of communication and dissemination of the obtained research results.	10. The doctoral student develops research reports, publishes the thesis and scientific articles in journals, participates in scientific events and consortia, and transfers research results to industry and the social environment, both at the national and international level.

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Students acquire and argue various principles of professional ethics.
2. Students describe in their own words the conclusions of approaching a scientific research case from the point of view of respecting the requirements of professional ethics.
Specific academic skills
1. The student applies fundamental ethical concepts to interpret simple situations in professional life.
2. The student uses, analyzes and compares examples of behaviour in professional life from an ethical point of view.

8. Contents

8.1. Course	Teaching and learning methods	Remarks ³
8.1.1. Ethics and academic integrity. Fundamental concepts and distinctions. How do we analyse an ethical problem? The framework of moral evaluation. Interdisciplinary and integrative approaches.	Lecture; Explanation; Conversation; Description; Problematization; Debate.	2 h
8.1.2. The role of the university in society. Why do we need ethics and integrity in academia? (Moral and etiquette rules in the academic space).	Lecture; Explanation; Conversation; Description; Problematization; Debate.	2 h
8.1.3. Institutional tools for promoting academic ethics (Legislative framework, codes, ethics committees. How do we conduct a critical discussion in a civilised way? University etiquette).	Lecture; Explanation; Conversation; Description; Problematization; Debate.	2 h
8.1.4. Scientific research and the originality of research results and scientific works. The normative framework	Lecture; Explanation; Conversation; Description; Problematization; Debate.	2 h

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.

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



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of scientific research. Ethical codes in scientific research. Deviations from good conduct in scientific research.		
8.1.5. Challenges and dilemmas (Academic freedom and disagreement in science). Are there public responsibilities of members of the academic community?	Lecture; Explanation; Conversation; Description; Problematization; Debate.	2 h
8.1.6. Applications (plagiarism, publication ethics, authorship and co-authorship, informed consent and research on human/animal subjects). Intellectual property. Ethics of intellectual property.	Lecture; Explanation; Conversation; Description; Problematization; Debate.	2 h
Bibliography		
1. C. Aslam, C-F Moraru, R. Paraschiv, Curs de deontologie și integritate academică, Universitatea Națională de Arte, Bucuresti, 2018.		
2. V. Dumitrascu, Etica si integritate academica. Provocari pentru organizatiile secolului XXI, Editura Universitara, Bucuresti, 2021.		
3. L. Papadima, (coord.), Deontologie academică. Curriculum cadru, Universitatea din București, 2018; http://mepopa.com/Pdfs/papadima_2017.pdf		
4. P. Singer, Tratat de etica, Polirom, Bucuresti, 2006.		
5. E. Socaciu, C. Vică, E. Mihailov, T. Gibea, V. Mureșan, M. Constantinescu, Etică și integritate academică, Editura Universității din București, 2018.		
6. E. E. Ștefan, Etica si integritate academica, Editura ProUniversitaria, Bucuresti, 2018.		
8.2. Seminar/ laboratory	Teaching and learning methods	Remarks
8.2.1. Interdisciplinary and integrative approaches.	Lecture; Explanation; Conversation; Description; Problematization	4 h
8.2.2. Professional responsibility in universities and research institutes	Lecture; Explanation; Conversation; Description; Problematization	4 h
8.2.3. Institutional tools for promoting academic ethics. Examples, case studies.	Lecture; Explanation; Conversation; Description; Problematization	4 h
8.2.4. Applying the concepts of ethics and integrity in the development of the doctoral thesis: case study on the originality of experimental data.	Lecture; Explanation; Conversation; Description; Problematization	4 h
8.2.5. The precautionary principle and risky research.	Lecture; Explanation; Conversation; Description; Problematization	4 h
8.2.6. Intellectual property. Ethics of intellectual property.	Lecture; Explanation; Conversation; Description; Problematization	4 h
Bibliography		
1. C. Aslam, C-F Moraru, R. Paraschiv, Curs de deontologie și integritate academică, Universitatea Națională de Arte, Bucuresti, 2018.		
2. V. Dumitrascu, Etica si integritate academica. Provocari pentru organizatiile secolului XXI, Editura Universitara, Bucuresti, 2021.		
3. L. Papadima, (coord.), Deontologie academică. Curriculum cadru, Universitatea din București, 2018; http://mepopa.com/Pdfs/papadima_2017.pdf		
4. P. Singer, Tratat de etica, Polirom, Bucuresti, 2006.		
5. E. Socaciu, C. Vică, E. Mihailov, T. Gibea, V. Mureșan, M. Constantinescu, Etică și integritate academică, Editura Universității din București, 2018.		
6. E. E. Ștefan, Etica si integritate academica, Editura ProUniversitaria, Bucuresti, 2018.		



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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	Understanding the processes discussed. Specificity of answers. Holistic thinking and approach.	The realization, presentation and defense of the written research project and (b) of the case study regarding the originality of the experimental data. Answers to questions related to solving real problems. Complaints are resolved by the discipline holder. Fraud in the preparation of the project is punished by expulsion, according to the ECST regulation of UBB.	80%
9.5. Seminar/ laboratory	Understanding of the processes discussed. Specificity of answers. Holistic thinking and approach. Ability to use different sources of information.	Carrying out and submitting various control tasks to the supervisor.	20%
9.6 Minimum standard for passing			
<ul style="list-style-type: none">• Minimum grade 5 for the presentation of the project and case study, and minimum grade 5 for the seminar activities.• Knowledge of the concepts used; solving real situations.			

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.



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10. SDG labels (Sustainable Development Goals)⁶

	X	Sustainable Development Generic Label						
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
								No label applies
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Date of entry:
29 ian 2026

Signature of course coordinator
Prof. habil. dr. eng. Graziella L. Turdean

Signature of seminar coordinator
Prof. habil. dr. eng. Graziella L. Turdean

Date of approval in
the doctoral school
council
30.01.2026

Signature of the head of the doctoral
school
Prof. dr. eng. Mircea Vasile Cristea

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."



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COURSE DESCRIPTION

Technologies for Capturing and Using CO₂ Applied in High Polluting Industrial Processes

University year 2026-2027

1. Information regarding the programme

1.1. Higher education institution	Babeș-Bolyai University
1.2. Faculty	Faculty of Chemistry and Chemical Engineering
1.3. Department	Doctoral School of Chemical Engineering
1.4. Field	Chemical Engineering
1.5. Level of study	Doctorate
1.6. Degree programme / Qualification	Chemical Engineering/Doctor in Chemical Engineering
1.7. Form of education	Full-time education

2. Course-related data

2.1. Course title	Technologies for Capturing and Using CO₂ Applied in High Polluting Industrial Processes			Course code	SDIC8114
2.2. Course coordinator	Prof. PhD Eng. Calin-Cristian Cormos				
2.3. Seminar coordinator	Prof. PhD Eng. Calin-Cristian Cormos				
2.4. Year of study	i	2.5. Semester	1	2.6. Type of assessment	Exam
2.7. Course status	Compulsory		2.8. Course type	Core subject	

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

3.1. Number of hours per week	3	of which: 3.2 course	1	3.3 seminar/laboratory	2
3.4. Total hours in the curriculum	36	of which: 3.5 course	12	3.6 seminar/laborator	24
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					60
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					48
Tutoring (professional guidance)					43
E xaminations					3
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	Not the case
4.2. skills-related	Not the case



5. Specific conditions (where applicable)

5.1. course-related	<ul style="list-style-type: none"> Students will attend the class with their mobile phones closed The delay will not be accepted
5.2. seminar/laboratory-related	<ul style="list-style-type: none"> Students will attend the seminar with their mobile phones closed The final report will be handed in at the latest in the first week of session For late delivery is penalized with 0.5 points / day It is forbidden to enter the seminar room with food

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

Professional competencies	
Competency code	Competency
PC1	Advanced knowledge and original knowledge generation skills in the field of chemical engineering for technologies, processes, production of new substances and materials by application of Carbon Capture, Utilization and storage (CCUS) systems
PC2	Capacity to design complex chemical processes and innovative materials across the entire laboratory, pilot and industrial scale chain
PC3	Capacity to design original technical solutions for the optimization and advanced control of chemical processes and technologies/methodologies for the production of materials with new properties
PC4	Digital competences to use advanced IT tools for the data analysis and the development of high-performance mathematical models, as well as for taking sustainable development decisions
PC5	Competences in developing technical, economic and environmental impact analyses for chemical processes and the production of new materials, in order to design innovative and sustainable solutions regarding the reduction of energy consumption, quality management, efficient use of raw materials and resource recovery
Transversal competencies	
Competency code	Competency
TC1	Ability to work autonomously in order to design, build and implement on one's own initiative the actions of the developed research plans
TC2	The ability to scientifically and professionally coordinate research teams within projects that aim to develop complex chemical products and innovative materials, as well as those that are multidisciplinary or that integrate research from several fields
TC3	Ability to act responsibly to achieve research objectives, assuming complex tasks to accomplish them
TC4	Ability to comply with ethical and academic-professional integrity norms to respect good conduct in scientific research
TC5	Ability to lead or participate in national or international research teams within research projects or to the transfer of research results to industry or society
TC6	The ability to use professional communication methods and disseminate original research results through publications, conferences, scientific communications and research reports

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.



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
PC1	1. The doctoral student acquires and recognizes advanced aspects of transfer phenomena (mass, heat, momentum), thermodynamics, kinetics, chemical/biochemical reaction and materials engineering, automatic control, process optimization, aspects at the border of their interference with scientific research	1. The doctoral student uses advanced knowledge to identify and formulate original research topics in order to develop innovative solutions and generate new knowledge
PC1 PC2	2. The doctoral student explains, compares and interprets advanced notions and concepts of chemical and materials engineering acquired, to identify problems in traditional or emerging technologies such as: bioprocessing, CO ₂ capture and use, hydrogen, multiscale modelling, use of AI and complex simulation, functional/advanced materials, electrochemical processes	2. The doctoral student justifies the choice and formulation of an original research topic in the field of chemical or materials engineering, which aims to find sustainable solutions to complex problems identified in specific industries (chemical, biochemical, materials, energy, pharmaceutical, environmental)
PC2 PC3 PC4	3. The doctoral student applies the principles and theoretical concepts of transfer phenomena, thermodynamics, kinetics, chemical reaction engineering, materials science, automatic control and process optimization to substantiate the original solution to the research topic	3. The doctoral student proposes an original research project, applies theoretical principles and concepts for the design of experimental or computational research methodology, for carrying out research activity on the chosen topic, involving process intensification methodologies, thermal integration, sustainable development, advanced mathematical modelling tools, experimental design, data analysis and analysis of the structure-property relationship of materials
PC5	4. The doctoral student critically analyses and compares the theoretical solution variants obtained for the research topic	4. The doctoral student analyses the performance of solution options on the research topic of innovative processes or materials, considering the aspects of technical, economic and environmental performance, including that of scaling up (from laboratory, pilot to industrial scale)
PC1 PC5	5. The doctoral student creates and conceptualizes the innovative solution obtained through research	5. The doctoral student creates and proposes innovative solutions to solve problems in chemical engineering processes or materials, highlighting the most efficient solution that integrates quality, cost and sustainable development requirements

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.



TC1 TC3	6. The doctoral student acquires the principles and methods of working under conditions of autonomy and responsibility	6. The doctoral student implements the research project with independent initiatives and decisions, assuming the consequences and being responsible for his own activity
TC2	7. The doctoral student acquires and recognizes the concepts, principles and methods of management and teamwork	7. The doctoral student coordinates or supervises research teams, manages projects and resources
TC5 TC6	8. The doctoral student acquires methods of communication and dissemination of the obtained research results	8. The doctoral student develops research reports, publishes the thesis and scientific articles in journals, participates in scientific events, consortia, transfers research results to industry and the social environment, both at national and international level

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Doctoral student knows the main elements used in the design and operation of modern production systems for reducing the environmental impact and a sustainable development of industrial systems
2. Doctoral student understands how to apply modern evaluation techniques for sustainable development of decarbonized production systems
3. Doctoral student applies adequate working tools for chemical process design in view of sustainable development
4. Doctoral student makes the difference between various techno-economic and environmental impact performance indicators used for process analysis
Specific academic skills
1. Doctoral student identifies the main research and development directions of CCUS technologies for sustainable development
2. Doctoral student makes the difference between integration and intensification methods applied in design and operation of decarbonized production systems
3. Doctoral student applies modern paradigms of chemical engineering to reduce the environmental impact of industrial sector

8. Content

8.1 Course	Teaching and learning methods	Remarks ³
8.1.1. Introductory notions related to greenhouse gas emissions, energy conversion systems (focusing on fossil fuels) through total oxidation (combustion, oxy-combustion) and partial (catalytic reforming, gasification). Other polluting industrial systems (metallurgy, cement, petrochemicals, etc.).	Presentation, discussion, case studies, exercises	
8.1.2. Introductory elements of carbon dioxide capture technologies. Capture of pre-, post- and oxy-combustion of carbon dioxide, gas-liquid and gas-solid systems used. Advantages, disadvantages and application areas of each technology. Technologies for the use of carbon dioxide. Poly-generation of total or partial		

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



decarbonized energy vectors (e.g., hydrogen, methanol, synthetic methane gas, Fischer-Tropsch synthesis, etc.).		
8.1.3. Basic elements of economic engineering. Capital costs and operating costs. Cost estimation methods. Calculating the present and future value of money and cash flow of an industrial process. Indices for measuring the profitability and profitability of a technological process. The economic potential of the process.		
8.1.4. Application of carbon capture and use technologies for the coal gasification process. Conceptual technological schemes, capture technologies used, process modelling and simulation, energy integration aspects, calculation of energy and cost penalties, estimation of energy production cost.		
8.1.5. Combustion and oxy-combustion processes of coal and lignite. Thermal power plants operated under and super-critical regime of the generated steam. Flue gas desulphurisation and denitrification. Evaluation of different methods of post-combustion capture of CO ₂ . Technical and economic evaluations.		
8.1.6. Chemical conversion systems for captured carbon dioxide. Exemplification for the process of synthesis of methanol using hydrogen produced from renewable sources.		
<p>Bibliography:</p> <ol style="list-style-type: none"> 1. Intergovernmental Panel on Climate Change (IPCC), Special report: Carbon Dioxide Capture and Storage, 2005, www.ipcc.ch. 2. R. Smith, Chemical process: Design and integration, John Wiley / Sons, 2nd edition, 2016. 3. W. D. Seider, J. D. Seader, D. R. Lewin, Product & process design principles, John Wiley / Sons, 2004. 4. C. Higman, M. Van der Burgt, Gasification, Burlington, Elsevier Science, 2003. 5 C.C. Cormos, Decarbonizarea combustibililor fosili solizi prin gazeificare, Presa Universitara Clujana, 2008. 		
8.2 Seminar / laboratory	Teaching and learning methods	Remarks
8.2.1. Introduction to chemical process modelling and simulation programs (ChemCAD, Aspen). Generating mass and energy balances used for techno-economic and environmental assessment of processes.	Presentation, discussion, exercises	
8.2.2. Numerical application for simulating the gasification process for electricity generation with pre-combustion capture of carbon dioxide. CO ₂ capture systems based on gas-liquid absorption using physical and chemical solvents.		
8.2.3. Aspects of energy integration of the coal gasification plant with pre-combustion CO ₂ capture, calculation of the energy penalty of the acquisition process. Estimation of technical		



and environmental performance (e.g., energy efficiency, CO ₂ capture rate, specific emissions, material consumption, etc.).		
8.2.4. Aspects of economic calculation of the coal gasification plant with pre-combustion CO ₂ capture, estimation of capital and operating costs of the plant. Calculation of the cost of electricity production in variants with and without CO ₂ capture. CO ₂ capture costs.		
8.2.5. Numerical application for simulating the synthesis process of methanol from captured CO ₂ and hydrogen from renewable sources. Estimation of technical-economic and environmental performance of the process. Estimation of capital and operating costs of the installation. Calculation of methanol production cost, comparison with conventional technologies (from methane gas without CO ₂ capture).		
8.2.6. Evaluation of the integration of the methanol synthesis process in a coal gasification plant. Evaluating the aspects of energy integration of the process using pinch analysis.		
<p>Bibliography:</p> <ol style="list-style-type: none"> 1. Intergovernmental Panel on Climate Change (IPCC), Special report: Carbon Dioxide Capture and Storage, 2005, www.ipcc.ch. 2. R. Smith, Chemical process: Design and integration, John Wiley / Sons, 2nd edition, 2016. 3. W. D. Seider, J. D. Seader, D. R. Lewin, Product & process design principles, John Wiley / Sons, 2004. 4. C. Higman, M. Van der Burgt, Gasification, Burlington, Elsevier Science, 2003. 5 C.C. Cormos, Decarbonizarea combustibililor fosili solizi prin gazeificare, Presa Universitara Clujana, 2008. 		

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	Assessment of knowledge	Written exam	100%
	Assessment of knowledge	Ongoing tests	
9.5 Seminar/laboratory	Activity during seminars	Discussions, answers to questions	
	Assessment of knowledge	Written exam	
9.6 Minimum standard for passing			
<ul style="list-style-type: none"> • "Satisfactory" grade for the exam according to the scale. • Knowledge of the introductory notions regarding the technologies of capture and use of carbon dioxide applied to different polluting industrial processes, technical-economic and environmental impact assessment, energy conversion systems integrated with technologies for capture and storage of carbon dioxide. 			

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.



10. Labels ODD (Sustainable Development Goals)⁶

	Sustainable Development Generic Label							
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
								No label applies
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Date of entry:
22.01.2026

Signature of course coordinator
Prof. PhD Eng.Cormoș Călin Cristian

Signature of seminar coordinator
Prof. PhD Eng.Cormoș Călin Cristian

Date of approval in the doctoral school council:
30.01.2026

Signature of the doctoral school director
Prof. PhD Eng.Cristea Vasile Mircea

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."



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COURSE DESCRIPTION

Advanced Process Control

Academic year 2025-2026

1. Programme-related data

1.1. Higher Education Institution	Babeș-Bolyai University of Cluj-Napoca
1.2. Faculty	Faculty of Chemistry and Chemical Engineering
1.3. Department	Doctoral School of Chemical Engineering
1.4. Field	Chemical Engineering
1.5. Level of study	Doctoral
1.6. Degree programme / Qualification	Chemical Engineering/Doctor
1.7. Form of education	Full-time Education

2. Course-related data

2.1. Course title	Advanced Process Control			Course code	SDIC8115
2.2. Course coordinator	Prof. dr. eng. Cristea Vasile Mircea				
2.3. Seminar coordinator	Prof. dr. eng. Cristea Vasile Mircea				
2.4. Year of study	I	2.5. Semester	1	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	3	of which: 3.2. course	1	3.3. seminar/ laboratory/ project	2
3.4. Total of hours in the curriculum	36	of which: 3.5. course	12	3.6. seminar/ laboratory	24
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					44
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					56
Tutoring (professional guidance)					36
Examinations					4
Other activities communication with the course coordinator					14
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	Basics related to chemical process control
4.2 skills-related	General computer skills (Matlab/Simulink) and knowledge of the basics of control systems using PID controllers

5. Specific conditions (where applicable)

5.1. course-related	Consulting the course topic
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5.2. seminar/laboratory-related	All seminar activities are mandatory Obtaining the "Passed" Qualification prerequisite for participation in the final examination/grading
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6.1. Competencies resulting from the completion of the degree programme (as referred to in the curriculum)¹

Professional competencies	
Competency code	Competency
CP1	Advanced knowledge and original knowledge generation skills in the field of chemical engineering for technologies, processes, production of new substances and materials
CP2	Capacity to design complex chemical processes and innovative materials across the entire laboratory, pilot and industrial scale chain
CP3	Capacity to design original technical solutions for the optimization and advanced control of chemical processes and technologies/methodologies for the production of materials with new properties
CP4	Digital competences to use advanced IT tools for the data analysis and the development of high-performance mathematical models, as well as for taking sustainable development decisions
CP5	Competences in developing technical, economic and environmental impact analyses for chemical processes and the production of new materials, in order to design innovative and sustainable solutions regarding the reduction of energy consumption, quality management, efficient use of raw materials and resource recovery
Transversal competencies	
Competency code	Competency
TC1	Ability to work autonomously in order to design, build and implement on one's own initiative the actions of the developed research plans
TC2	The ability to scientifically and professionally coordinate research teams within projects that aim to develop complex chemical products and innovative materials, as well as those that are multidisciplinary or that integrate research from several fields
TC3	Ability to act responsibly to achieve research objectives, assuming complex tasks to accomplish them
TC4	Ability to comply with ethical and academic-professional integrity norms to respect good conduct in scientific research
TC5	Ability to lead or participate in national or international research teams within research projects or to the transfer of research results to industry or society
TC6	The ability to use professional communication methods and disseminate original research results through publications, conferences, scientific communications and research reports

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

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.



CP1	1. The doctoral student acquires and recognizes advanced aspects of transfer phenomena (mass, heat, momentum), thermodynamics, kinetics, chemical/biochemical reaction and materials engineering, automatic control, process optimization, aspects at the border of their interference with scientific research	1. The doctoral student uses advanced knowledge to identify and formulate original research topics in order to develop innovative solutions and generate new knowledge
CP2 CP3 CP4	3. The doctoral student applies the principles and theoretical concepts of transfer phenomena, thermodynamics, kinetics, chemical reaction engineering, materials science, automatic control and process optimization to substantiate the original solution to the research topic	3. The doctoral student proposes an original research project, applies theoretical principles and concepts for the design of experimental or computational research methodology, for carrying out research activity on the chosen topic, involving process intensification methodologies, thermal integration, sustainable development, advanced mathematical modelling tools, experimental design, data analysis and analysis of the structure-property relationship of materials
CP5	4. The doctoral student critically analyses and compares the theoretical solution variants obtained for the research topic	4. The doctoral student analyses the performance of solution options on the research topic of innovative processes or materials, considering the aspects of technical, economic and environmental performance, including that of scaling up (from laboratory, pilot to industrial scale)
CP4 CP5	5. The doctoral student evaluates and argues the validity of the theories used to obtain solutions to the research topic	5. The doctoral student evaluates the results of original solutions to the research topic using the analysed performance criteria and appropriate digital tools
CP1 CP5	6. The doctoral student creates and conceptualizes the innovative solution obtained through research	6. The doctoral student creates and proposes innovative solutions to solve problems in chemical engineering processes or materials, highlighting the most efficient solution that integrates quality, cost and sustainable development requirements
CT1 CT3	7. The doctoral student acquires the principles and methods of working under conditions of autonomy and responsibility	7. The doctoral student implements the research project with independent initiatives and decisions, assuming the consequences and being responsible for his own activity
CT5 CT6	10. The doctoral student acquires methods of communication and dissemination of the obtained research results	10. The doctoral student develops research reports, publishes the thesis and scientific articles in journals, participates in scientific events, consortia, transfers research results to industry and the social environment, both at national and international level

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Capacity to conceive, design and simulate an advanced automatic control system for complex chemical processes
2. Capacity to develop a mathematical model dedicated for a complex process, intended for model-based automatic control



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3. Capacity to choose a control solution based on advanced control algorithms, as a result of the analysis of the dynamic and steady state behaviour of a chemical/biochemical process
4. Capacity to operate a complex chemical plant using advanced control and monitoring systems
Specific academic skills
1. Ability to think based on the system bases approach, holistically, critically, argumentatively and creatively
2. Ability to solve research and production problems of high complexity with originality, using advanced control systems
3. Ability to analyse a process based on mathematical models, control systems and with the support of information technology tools
4. Ability to document, analyse, and work independently and to effectively communicate results

8. Contents

8.1. Course	Teaching and learning methods	Remarks ³
8.1.1. Tools for describing the discrete time systems behaviour. Elements of statistical data processing Basic concepts, keywords: discrete controller design, data collection and filtering, exploratory analysis, use of statistical tests, interpretation of results	Teaching Computer simulation PowerPoint presentation Interactive exercises	Materials used: PowerPoint presentations, Matlab software and Toolboxes for examples and applications 4h
8.1.2. Advanced process control based on mathematical models. Predictive control. Basic concepts, keywords: Analytical models and models based on experimental data ("white/grey/black-box"), design of model-based control systems	Teaching Computer simulation PowerPoint presentation Interactive exercises	Materials used: PowerPoint presentations, Matlab software and Toolboxes for examples and applications 3h
8.1.3. Optimal control of processes. Basic concepts, keywords: optimal control in steady-state and dynamic regimes; control of continuous and discrete time processes	Teaching Computer simulation PowerPoint presentation Interactive exercises	Materials used: PowerPoint presentations, Matlab software and Toolboxes for examples and applications 1h
8.1.4. Multivariable control of complex chemical processes. Basic concepts, keywords: decentralized and centralized multivariable control, decoupling, tuning	Teaching Computer simulation PowerPoint presentation Interactive exercises	Materials used: PowerPoint presentations, Matlab software and Toolboxes for examples and applications 1h
8.1.5. Fuzzy controllers. Basic concepts, keywords: fuzzification, logical inference, defuzzification, fuzzy control system design	Teaching Computer simulation PowerPoint presentation Interactive exercises	Materials used: PowerPoint presentations, Matlab software and Toolboxes for examples and applications 1h
8.1.6. Controllers using Artificial Neural Networks (ANNs).	Teaching Computer simulation	Materials used: PowerPoint presentations, Matlab software and

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



Basic concepts, keywords: model predictive control based on nonlinear ANN models, design of control systems using ANN models	PowerPoint presentation Interactive exercises	Toolboxes for examples and applications 1h
8.1.7. Plantwide control systems. Basic concepts, keywords: plantwide control strategies, primary and secondary controlled variables, hierarchical design approach of base-top and top-bottom type	Teaching Computer simulation PowerPoint presentation Interactive exercises	Materials used: PowerPoint presentations, Matlab software and Toolboxes for examples and applications 1h
Bibliography 1. V. M. Cristea, S. P. Agachi, Elemente de Teoria Sistemelor, Editura Risoprint, Cluj-Napoca, 2002, 2. Paul Șerban Agachi, Mircea Vasile Cristea, Alexandra Ana Csavdări, Botond Szilágyi, Advanced Process Engineering Control, De Gruyter Publishing House, De Gruyter GmbH, Berlin, 2016, 3. Agachi P.S., Cristea M.V, Basic Process Engineering Control, De Gruyter GmbH, Berlin, ISBN: 978-3-11-028981-7, e-ISBN: 978-3-11-028982-4, 360 p., 2014, 4. P.S. Agachi, Z.K. Nagy, M.V. Cristea, A. Imre-Lucaci – Model Based Control, Case studies in process engineering, Ed. Wiley-VCH, Weinheim, 2006. Additional Bibliography 5. F. Greg Shinsky - Process Control Systems Application, Design and Tuning, Ed. Mc.Graw Hill, New York, 1996, 6. P. Serfelis, M.C. Georgiadis, The Integration of Process Design and Control, Elsevier, 2004. Note: titles can be accessed at the Library of the Department of Chemical Engineering at the Faculty of Chemistry and Chemical Engineering branch of the Central University Library "Lucian Blaga" and at the Library of the Technical University of Cluj-Napoca.		
8.2. Seminar/ laboratory	Teaching and learning methods	Remarks
8.2.1. Description of the behaviour of discrete time systems. Elements of statistical data processing. Examples. Basic concepts, keywords: discrete controller design, data collection and filtering, exploratory analysis, use of statistical tests, interpretation of results	Seminar Practical laboratory work Interactive discussions Individual study assignment	Student obligations: reading the course, the related bibliography. Assessment of the individual work results. 6h
8.2.2. Nonlinear predictive control based on analytical mathematical models. Examples and applications. Basic concepts, keywords: Applications to the design of model-based control systems and controller tuning (drying of electrical insulators, fluid catalytic cracking unit, pollution control in rivers)	Seminar Practical laboratory work Interactive discussions Individual study assignment	Student obligations: reading the course, the related bibliography. Assessment of the individual work results. 6h
8.2.3. Optimal process control. Examples and applications. Basic concepts, keywords: Optimal control applications; controller design and tuning; control, stability (control of wastewater treatment plant operation, temperature control in exothermic reactors, pH control in reactor cascades)	Seminar Practical laboratory work Interactive discussions Individual study assignment	Student obligations: reading the course, the related bibliography. Assessment of the individual work results. 4h
8.2.4. Multivariable control of complex chemical processes. Examples and applications. Basic concepts, keywords: Applications of	Seminar Practical laboratory work Interactive discussions Individual study assignment	Student obligations: reading the course, the related bibliography. Assessment of the individual work results.



comparison of decentralized and centralized control, design and tuning of controllers (fluidized catalytic cracking plant, wastewater treatment plant, CO ₂ absorption in MEA).		2h
8.2.5. Fuzzy control. Examples and applications. Basic concepts, keywords: Applications of fuzzy control systems design (temperature control, moisture control in the drying process of electrical insulators, catalyst inventory control in the fluid catalytic cracking unit).	Seminar Practical laboratory work Interactive discussions Individual study assignment	Student obligations: reading the course, the related bibliography. Assessment of the individual work results. 2h
8.2.6. Controllers using Artificial Neural Networks (ANNs). Examples and applications. Basic concepts, keywords: Applications of predictive control based on nonlinear ANN models, design and tuning of ANN control systems (fluid catalytic cracking unit, wastewater treatment plant, alcoholic fermentation bioreactor).	Seminar Practical laboratory work Interactive discussions Individual study assignment	Student obligations: reading the course, the related bibliography. Assessment of the individual work results. 2h
8.2.7. Plantwide control systems. Examples. Basic concepts, keywords: base-top and top-bottom hierarchical design approach (fluid catalytic cracking unit).	Seminar Practical laboratory work Interactive discussions Individual study assignment	Student obligations: reading the course, the related bibliography. Assessment of the individual work results. 2h
Bibliography 1. Paul Șerban Agachi, Mircea Vasile Cristea, Alexandra Ana Csavdări, Botond Szilágyi, Advanced Process Engineering Control, De Gruyter Publishing House De Gruyter GmbH, Berlin, 2016, 2. Mihaela Iancu, P.Ș.Agachi, M.Mogoș, M.Cristea, Automatizarea Proceselor Chimice – Lucrări de Laborator, Presa Universitară Clujeană, UBB, 2012, 3. Model Predictive Control Toolbox, Matlab, Documentation accompanying toolbox, 4. Fuzzy Logic Toolbox, Matlab, Documentation accompanying toolbox. 5. Neural Network Toolbox, Matlab, Documentation accompanying toolbox. Additional Bibliography 6. G. Stephanopoulos, Chemical Process Control An Introduction to Theory and Practice, Prentice Hall, 1984, 7. Control System Toolbox, Matlab, Documentation accompanying toolbox,		

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	Understanding the processes discussed Specificity of answers Holistic thinking and approach	Project presentation	80%

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.



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9.5. Seminar/ laboratory	Ability to use diverse sources of information	Examination during the seminar	10%
	Understanding the processes discussed Specificity of answers Holistic thinking and approach	Examination during the seminar	10%
9.6 Minimum standard for passing			
Evaluated with a grade of "Passed" for each of the examinations/presentations.			

10. SDG labels (Sustainable Development Goals)⁶

	<input type="radio"/>	Sustainable Development Generic Label						
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
								No label applies
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Date of entry:
25.01.2026

Signature of course coordinator

Prof. Cristea V.M

Signature of seminar coordinator

Prof. Cristea V.M

Date of approval in the doctoral school council:
30.01.2026

Signature of the doctoral school director

Prof. Cristea V.M

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."



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COURSE DESCRIPTION

Evaluation and Statistical Processing of Experimental Data

Academic year 2026-2027

1. Programme-related data

1.1. Higher Education Institution	Babeș-Bolyai University of Cluj-Napoca
1.2. Faculty	Faculty of Chemistry and Chemical Engineering
1.3. Department	Doctoral School of Chemical Engineering
1.4. Field	Chemical Engineering
1.5. Level of study	Doctoral (PhD)
1.6. Degree programme / Qualification	Chemical Engineering / Doctor (PhD)
1.7. Form of education	Day (with frequency)

2. Course-related data

2.1. Course title	Evaluation and Statistical Processing of Experimental Data			Course code	SDIC8117
2.2. Course coordinator	Assoc. Prof. Dr. Eng. Alexandra Ana Csavdari				
2.3. Seminar coordinator	Assoc. Prof. Dr. Eng. Alexandra Ana Csavdari				
2.4. Year of study	I	2.5. Semester	1	2.6. Type of assessment	Progress check
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	3	of which: 3.2. course	1	3.3. seminar/ laboratory/ project	2
3.4. Total of hours in the curriculum	36	of which: 3.5. course	12	3.6. seminar/ laboratory	24
Time allocation for individual study (IS) and self-taught activities (ST)					hours
Learning from textbooks, course materials, bibliography, and notes (IS)					36
Additional research in the library, on subject-specific electronic platforms, and on-site					36
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					90
Tutoring (professional guidance)					24
Examinations					4
Other activities (two-way communication with the course coordinator)					24
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	Thorough knowledge of the units of measurement used in chemical engineering, tabular and graphical representation of experimental data and experimental database management.
4.2. skills-related	General skills in the use of common mathematical tools for derivation, integration and statistical calculation.

5. Specific conditions (where applicable)

5.1. course-related	Consultation of the course topic.
5.2. seminar/laboratory-related	All seminar hours are mandatory.



Qualifying grade for participation in the final examination/grading.

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

Professional competencies	
Competency code	Competency
PC1	Advanced knowledge and original knowledge generation skills in the field of chemical engineering for technologies, processes, production of new substances and materials.
PC4	Digital competences to use advanced IT tools for the data analysis and the development of high-performance mathematical models, as well as for taking sustainable development decisions.
PC5	Competences in developing technical, economic and environmental impact analyses for chemical processes and the production of new materials, in order to design innovative and sustainable solutions regarding the reduction of energy consumption, quality management, efficient use of raw materials and resource recovery.
Transversal competencies	
Competency code	Competency
TC1	Ability to work autonomously in order to design, build and implement on one's own initiative the actions of the developed research plans.
TC2	The ability to scientifically and professionally coordinate research teams within projects that aim to develop complex chemical products and innovative materials, as well as those that are multidisciplinary or that integrate research from several fields.
TC3	Ability to act responsibly to achieve research objectives, assuming complex tasks to accomplish them.

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
PC1	1. The doctoral student acquires and recognizes advanced aspects of transfer phenomena (mass, heat, momentum), thermodynamics, kinetics, chemical/biochemical reaction and materials engineering, automatic control, process optimization, aspects at the border of their interference with scientific research.	1. The doctoral student uses advanced knowledge to identify and formulate original research topics in order to develop innovative solutions and generate new knowledge.
PC4 PC5	2. The doctoral student evaluates and argues the validity of the theories used to obtain solutions to the research topic.	2. The doctoral student evaluates the results of original solutions to the research topic using the analysed performance criteria and appropriate digital tools.

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.



TC2	3. The doctoral student acquires and recognizes the concepts, principles and methods of management and teamwork	3. The doctoral student coordinates or supervises research teams, manages projects and resources
TC1 TC3	4. The doctoral student acquires the principles and methods of working under conditions of autonomy and responsibility	4. The doctoral student implements the research project with independent initiatives and decisions, assuming the consequences and being responsible for his own activity

7. Subject-specific learning outcomes

Knowledge and comprehension	
1.	The doctoral student acquires and recognizes advanced aspects (equations and mathematical models, values and units of measurement) of transfer phenomena, thermodynamics, kinetics, chemical/ biochemical reaction and materials engineering, process optimization, and can apply them in scientific research with the aim of innovation.
2.	The doctoral student qualitatively evaluates and statistically interprets experimental data collected from research and/ or industrial facilities, builds and manages experimental/ technical/ financial databases, and argues the validity of theories used to obtain solutions to the research topic.
3.	The doctoral student acquires and recognizes the concepts, principles and methods of management and teamwork, regarding the acquisition and management of experimental/ technical/ financial databases, data collected from research and/ or industrial facilities.
4.	The doctoral student acquires the principles and methods of working under conditions of autonomy and responsibility, regarding the acquisition and management of experimental/ technical/ financial databases, data collected from research and/ or industrial facilities, respectively regarding their qualitative and quantitative analysis/ evaluation from a statistical point of view.
Specific academic skills	
1.	The doctoral student uses advanced knowledge of mathematical models of processes, data collected from research and/ or industrial facilities as well as the results of their statistical evaluation and interpretation, to identify and formulate original research topics in order to develop innovative solutions and generate new knowledge.
2.	The doctoral student qualitatively evaluates and statistically interprets the results of original solutions used within his/ her research topic, by using both the analysed performance criteria and the appropriate digital tools.
3.	The doctoral student coordinates or supervises research teams, manages projects and resources, regarding the acquisition and management of experimental/ technical/ financial databases, for data collected from research and/ or industrial facilities.
4.	The doctoral student implements the research project with independent initiatives and decisions, assuming the consequences and being responsible for his/ her own activity, regarding the acquisition and management of experimental/ technical/ financial databases, for data collected from research and/ or industrial facilities, respectively, regarding their qualitative and quantitative analysis/ evaluation from a statistical point of view.

8. Contents

8.1. Course	Teaching and learning methods	Remarks³
8.1.1. Units of measurement of quantities used in the chemical industry.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour
8.1.2. Correct presentation of multiple experimental data in tables and graphs.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case	Face-to-face time – 1 hour

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



	studies.	
8.1.3. Construction and management of experimental databases.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour
8.1.4. Descriptive statistics of data sets.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour
8.1.5. Statistical testing of databases based on analysis of variance (ANOVA).	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour
8.1.6. Linear and multilinear regression.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour
8.1.7. Fitting experimental data to various mathematical equations.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour
8.1.8. Numerical derivation.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour
8.1.9. Numerical integration.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour
8.1.10. Matrix calculus with applications in chemical engineering.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour
8.1.11. Sources of experimental errors. Propagation of errors through calculation algorithms.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour
8.1.12. Elements of experimental design.	Lecture, Explanation, Conversation, Demonstration, Problem-solving, Use of interactive exercises and case studies.	Face-to-face time – 1 hour

Bibliography:

1. S. Ellison, V. Barwick, T. Duguid Farrant, "Practical Statistics for the Analytical Scientist. A Bench Guide", 2nd Edition, RSC Publishing, Cambridge, 2009.
2. P.W. Atkins, „Tratat de Chimie Fizică”, Editura Tehnică, București, 1996. (sau „Physical Chemistry” oricare dintre ediții).
3. M. Geană, A.Veis, P. Ionescu, G. Ivănuș, „Proprietățile fizice ale fluidelor. Metode de calcul”, Editura Tehnică, București, 1993.
4. G. Niac, V. Voiculescu, I. Baldea, M. Preda, „Formule tabele probleme de chimie fizică”, Editura Dacia, Cluj-Napoca, 1984.
5. Gh. Lupușor, E. Merica, C. Gorea, V. Bucea-Gorduză, „Ingineria sintezei intermediarilor aromatici”, Editura Tehnică, București, 1977.
6. Electronic course support.

Note: The bibliography can be accessed at the Library of the Department of Chemical Engineering at the branch of the Faculty of Chemistry and Chemical Engineering of the Central University Library "Lucian Blaga" in Cluj-Napoca.



8.2. Seminar/ laboratory	Teaching and learning methods	Remarks
8.2.1. Review of units of measurement used in various fields; Their standardization and transformation into the metric system. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.2. Efficient methods for building and managing experimental databases. Data security. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.3. Forms of table and graphical presentation (bi- and multi-dimensional) of experimental data. Their interpretation. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.4. Statistical evaluation of mono-dimensional databases based on descriptive statistics indicators. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.5. Mono- and bi-factorial ANOVA statistical testing of databases. Working hypotheses. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.7. Statistical determination of the coefficients of the proposed mathematical equation. Various statistical indicators for evaluating the predictive quality of these equations. Error distribution. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.6. Linear and multilinear regression. Importance. Statistical determination of regression coefficients. Various statistical indicators for evaluating the predictive quality of regressions. Error distribution. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.7. Statistical determination of the coefficients of the proposed mathematical equation. Various statistical indicators for evaluating the predictive quality of these equations. Error distribution. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.8. Numerical derivation. Importance. Significance of the first two derivatives. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.9. Numerical integration. Importance. Significance of multiple integrals. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.10. Applications of matrix calculus in chemical engineering. Importance.	Seminar. Interactive discussions and exercises;	Face-to-face time – 2 hours



Examples and case studies.	Case studies; Interactive exercises; Individual study assignment.	
8.2.11. Evaluation of sources of errors affecting experimental data. Evaluation of error propagation when subjecting experimental data to mathematical processing. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
8.2.12. Applications of experimental design. Importance. Examples and case studies.	Seminar. Interactive discussions and exercises; Case studies; Interactive exercises; Individual study assignment.	Face-to-face time – 2 hours
Bibliography:		
1. S. Ellison, V. Barwick, T. Duguid Farrant, "Practical Statistics for the Analytical Scientist. A Bench Guide", 2 nd Edition, RSC Publishing, Cambridge, 2009.		
2. P.W. Atkins, „Tratat de Chimie Fizică”, Editura Tehnică, București, 1996. (sau „Physical Chemistry” oricare dintre ediții).		
3. M. Geană, A.Veis, P. Ionescu, G. Ivănuș, „Proprietățile fizice ale fluidelor. Metode de calcul”, Editura Tehnică, București, 1993.		
4. G. Niac, V. Voiculescu, I. Baldea, M. Preda, „Formule tabele probleme de chimie fizică”, Editura Dacia, Cluj-Napoca, 1984.		
5. Gh. Lupușor, E. Merica, C. Gorea, V. Bucea-Gorduza, „Ingineria sintezei intermediarilor aromatici”, Editura Tehnică, București, 1977.		
6. Electronic course support.		
Note: The bibliography can be accessed at the Library of the Department of Chemical Engineering at the branch of the Faculty of Chemistry and Chemical Engineering of the Central University Library "Lucian Blaga" in Cluj-Napoca.		

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	Understanding of the processes and calculation/ interpretation methods discussed. Specificity of answers.	Continuous oral formative assessment throughout the semester.	25%
	Holistic thinking and approach in the evaluation and statistical processing of experimental data.	Continuous oral formative assessment throughout the semester.	25%
9.5. Seminar/ laboratory	Understanding of the discussed processes. Specificity of answers. Holistic thinking and approach.	Continuous oral formative assessment throughout the semester.	25%
	Ability to use different sources of information	Continuous oral formative assessment throughout the semester.	25%
9.6 Minimum standard for passing			
The grade "Admitted" for each of the evaluation criteria.			

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.



10. SDG labels (Sustainable Development Goals)⁶

	<input type="radio"/>	Sustainable Development Generic Label							
1 FĂRĂ SĂRĂCIE 	2 FOAMETE "ZERO" 	3 SĂNĂTATE ȘI BUNĂSTĂRE 	4 EDUCAȚIE DE CALITATE 	5 EGALITATE DE GEN 	6 APĂ CURĂȚĂ ȘI SĂNĂTATE 	7 ENERGIE CURĂȚĂ ȘI LA PREȚURI ACCESIBILE 	8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ 	9 INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ 	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
10 INEGALITĂȚI REDUSE 	11 ORAȘE ȘI COMUNITĂȚI DURABILE 	12 CONSUM ȘI PRODUCȚIE RESPONSABILE 	13 ACȚIUNE CLIMATICĂ 	14 VIAȚĂ ACVATICĂ 	15 VIAȚĂ TERESTRĂ 	16 PACE, JUSTIȚIE ȘI INSTITUȚII EFICIENTE 	17 PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR 	No label applies	
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Date of entry:
24.01.2026

Signature of course coordinator

Assoc. Prof. Dr. Eng. Alexandra Csavdari

Signature of seminar coordinator

Assoc. Prof. Dr. Eng. Alexandra Csavdari

Date of approval in the doctoral school council:
30.01.2026

Signature of the head of doctoral school

Prof. Cristea V.M

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."