COURSE DESCRIPTION

Sustainable Design of Industrial Processes

Academic year 2026 - 2027

1. Programme-related data

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

2. Course-related data

2.1. Course title	**Sustainable Design of Industrial Processes**			Course code	**CME7320**
2.2. Course coordinator	Prof. PhD. Ana-Maria Cormoş				
2.3. Seminar coordinator	Prof. PhD. Ana-Maria Cormoş				
2.4. Year of study	I	2.5. Semester	2	2.6. Type of assessment	Exam
2.7. Course status	Compulsory			2.8. Course type	Specialisation subject

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

3.1. Number of hours per week	**4**	of which: 3.2. course	**2**	3.3. ~~seminar/ laboratory~~/ project	**2**
3.4. Total of hours in the curriculum	56	of which: 3.5. course	28	3.6. ~~seminar~~/ laboratory	**28**
Time allocation for individual study (IS) and self-taught activities (ST)					**hours**
Learning from textbooks, course materials, bibliography, and notes (IS)					12
Additional research in the library, on subject-specific electronic platforms, and on-site					18
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					28
Tutoring (professional guidance)					8
Examinations					3
Other activities					-
3.7. Total hours of individual study (IS) and self-taught activities (ST)				**69**	
3.8. Total hours per semester				**125**	
3.9. Number of credits				**5**	

4. Prerequisites (where applicable)

4.1. curriculum-related	Not applicable
4.2 skills-related	Not applicable

5. Specific conditions (where applicable)

5.1. course-related	• The teaching activity is carried out in accordance with the Code of Ethics and Professional Ethics of UBB 24051/10.12.2019 and the Guide to combating discrimination • Students will attend the class with their mobile phones closed
5.2. seminar/laboratory-related	• Students will attend the laboratory with their mobile phones closed • Students will attend the laboratory with the assigned homework solved • The project / calculations will be given to the course coordinator

	in the following week after performing the work; Delays will be penalised with 0.5 points/day • Computers will be turned off by students at the end of laboratory activities and the workplace will be left clean and tidy.

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

Professional competencies	
Competency code	**Competency**
PC1	Description, analysis and use of elaborate theories and concepts in the fields of chemistry and process advanced chemical engineering.
PC2	Technological design of processes, equipment and apparata specific to process engineering for the improvement of performances of biochemical and chemical processes by using computer-assisted instruments (CAD) and principles of longterm development.
PC3	Development and use of mathematical models and simulators in process engineering for diagnosis of problems, analysis of optimum operating systems and control of (bio)chemical processes.
PC4	Development of processes, apparatus and equipment specific to process engineering by promoting new solutions for process intensification, optimum operation and control.
Transversal competencies	
Competency code	**Competency**
TC1	Independent execution of complex professional assignments and autonomous development of project-research activities by using computer-assisted techniques and by observing the norms of professional ethics and moral conduct.
TC2	Self-assessment of professional performances and determining the continuous training needs, permanent information and documentation in the field of activity and related areas, according to the needs of the labour market.

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

Learning outcomes targeted by the subject		
Competency code	**Knowledge and comprehension**	**Specific academic skills**
PC2 **TC1**	1. Performing a critical analysis based on CAD tools, to identify possible solutions to complex problems of designing equipment and plants in a chemical process	1. Development of integrated projects, based on CAD tools, for the creative development of the design of devices, equipment and plants in the chemical process industries
PC6 **TC2**	2. Knowledge of concepts and theories specific to resources and quality management for process engineering, in the context of sustainable development	2. Use of qualitative and quantitative methods for assessing risk factors, operational safety and management, in the development of new projects for resources and quality management

7. Subject-specific learning outcomes

Knowledge and comprehension
1. Use of extensive design knowledge for explanation and interpretation of technological design solutions of industrial processes, equipment and devices for sustainable development
2. Assessment and critical-constructive analysis of processes, devices and equipments based on concepts, theories, models, methods and design practices for sustenable chemical processes

[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.

3. Development of mathematical models and implementation in simulators for the evaluation of the process performance by identifying operational and management solutions with economic benefits, increased energy efficiency, increased operational safety and low environmental impact
Specific academic skills
1. Use of the conceptual and methodological research apparatus to develop new/original theoretical approaches and products/technology with practical applications.
2. Ability to elaborate statistical and analytical, steady state and dynamic mathematical models, to build and use software simulators which represent the behaviour of the real industrial processes, in concordance with sustenable the goal of the investigation of it
3. Proper selection and use of the assessment methods for the pertinent interpretation of the research results by drawing conclusions and arguing the proposed solutions.

8. Contents

8.1. Course	**Teaching and learning methods**	**Remarks**
8.1.1 Introduction in process design for sustainability - "triple bottom line" - integrates technical, environmental, social, and economic factors	Explanation; Conversation; Description; Conceptualization	2
8.1.2 Analysis of climate change, resource management, and the enabling innovative & decarbonized technologies of process industry	Explanation; Conversation; Description; Conceptualization	4
8.1.3 Overview of national and international sustainability standards and the Sustainable Development Goals (SDGs)	Explanation; Conversation; Description; Conceptualization	2
8.1.4 Circular economy vs linear economy, reducing non-renewable raw material consumption, enhancing recyclability and renewable material sources (including CO_2 utilization)	Explanation; Conversation; Description; Conceptualization	2
8.1.5 Design of safer, cleaner chemical processes and the assessment of bio-based materials (green chemistry/ green engineering concepts)	Explanation; Conversation; Description; Conceptualization	2
8.1.6 Renewable energy integration into various process industries: Assessing the feasibility of integrating solar, wind, or hydrogen technologies into industrial processes.	Explanation; Conversation; Description; Conceptualization	4
8.1.7 Process Intensification and Integration: Heat and mass integration using Pinch technology; Exploring equipment that combines multiple steps.	Explanation; Conversation; Description; Conceptualization	4
8.1.8 Energy, Economic, and Environmental (3E) for sustainable design of industrial processes integrating CO_2 capture and utilization.	Explanation; Conversation; Description; Conceptualization	4
8.1.9 Identification and use of Key Performance Indicators (KPIs) to monitor and control industrial sustainability.	Explanation; Conversation; Description; Conceptualization	2
8.1.10 Shift from designing products to designing sustainable systems that satisfy current economic, environmental and societal needs – final remarks	Explanation; Conversation; Description; Conceptualization	2

Bibliography
1. Gyorgy Szekely, Sustainable Process Engineering, De Gruyter, Berlin, 2021.
2. David T. Allen and David R. Shonnard, Green Engineering: Environmentally Conscious Design of Chemical Processes, Prentice-Hall, Inc., 2002
3. ***, Green sustainable process for chemical and environmental engineering and science, Carbon Dioxide Capture and Utilization, Elsevier Inc. All, 2023
4. Jeffery P. Perl, Sustainability Engineering for Enhanced Process Design and Manufacturing Profitability. Balancing the Environment through Renewable Resources, Springer, 2024.
5. Richard Turton, Analysis, Synthesis and Design of Chemical Processes, Prentice Hall, 2012
6. Robin Smith, Chemical Process: Design and Integration, John Wiley & Sons, 2005
7. Electronic databases (Science Direct, Scopus, SpringerLink, Web of Science, Wiley Journals, Proquest Journals, etc.)

Note: The bibliographical elements can be consulted at the Library of the Department of Chemical Engineering at the Faculty of Chemistry and Chemical Engineering.

8.2. Laboratory	Teaching and learning methods	Remarks
8.2.1. Process simulators and green metric analysis for sustainable design of climate neutral processes.	Explanation; Conversation; Description; Conceptualization	4
8.2.2 "Designing a sustainable production plant" – process simulation for various industrial systems integrated with CO_2 capture and utilization (e.g. heat and power production, cement / steel / chemicals etc.)	Explanation; Conversation; Description; Conceptualization	8
8.2.3 Process integration for minimisation of external utility use. Key technical performance indicators calculation for various case studies of decarbonized systems.	Explanation; Conversation; Description; Conceptualization	4
8.2.4 Techno-economic evaluations to balance capital investment with long-term environmental savings.	Explanation; Conversation; Description; Conceptualization	6
8.3.5 Evaluation of environmental impact of a product from raw material through manufacturing and use/reuse.	Explanation; Conversation; Description; Conceptualization	4
8.2.6 Quantification of techno-economic and environmental impact for relevant case studies.	Explanation; Conversation; Description; Conceptualization	2

Bibliography

1. Gyorgy Szekely, Sustainable Process Engineering, De Gruyter, Berlin, 2021.
2. David T. Allen and David R. Shonnard, Green Engineering: Environmentally Conscious Design of Chemical Processes, Prentice-Hall, Inc., 2002
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5. Richard Turton, Analysis, Synthesis and Design of Chemical Processes, Prentice Hall, 2012
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9. Evaluation

Type of activity	9.1 Evaluation criteria[3]	9.2 Evaluation methods[4]	9.3 Percentage in the final grade
9.4. Course	The correctness of the results for the required evaluations. Representation and proper analysis of the results.	Individual Project	70%
9.5. Seminar/ laboratory	The correctness of answers - learning and understanding of issues presented in the seminar / laboratory activities. The activity carried out at the seminar/laboratory.	Exercises and homeworks	30%
9.6 Minimum standard for passing			
• The mark 5 (five) for the assessment of each of the assessment criteria. • Knowledge about the basic concepts of sustainable design of industrial processes			

[3] 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.

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

10. SDG labels (Sustainable Development Goals)[5]

	○	Sustainable Development Generic Label						
1 FĂRĂ SĂRĂCIE	2 FOAMETE „ZERO”	3 SĂNĂTATE ȘI BUNĂSTARE	4 EDUCAȚIE DE CALITATE	5 EGALITATE DE GEN	6 APĂ CURATĂ ȘI SANITAȚIE	7 ENERGIE CURATĂ ȘI LA PREȚURI ACCESIBILE	8 MUNCĂ DECENTĂ ȘI CREȘTERE ECONOMICĂ	9 INDUSTRIE, INOVAȚIE ȘI INFRASTRUCTURĂ
○	○	○	◉	○	○	○	○	○
10 INEGALITĂȚI REDUSE	11 ORAȘE ȘI COMUNITĂȚI DURABILE	12 CONSUM ȘI PRODUCȚIE RESPONSABILE	13 ACȚIUNE CLIMATICĂ	14 VIAȚA ACVATICĂ	15 VIAȚA TERESTRĂ	16 PACE, JUSTIȚIE ȘI INSTITUȚII EFICIENTE	17 PARTENERIATE PENTRU REALIZAREA OBIECTIVELOR	No label applies
○	○	○	○	○	○	○	○	○

Date of entry:
23.04.2026

Semnătura titularului de curs

Prof. Dr. Ana-Maria Cormoș

Semnătura titularului de curs

Prof. Dr. Ana-Maria Cormoș

Date of approval in the department:
...

Semnătura directorului de departament

Prof. habil. dr. eng. Graziella L. Turdean

[5] 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."*