COURSE SYLLABUS

1. Data about the program

1.1 Higher education institution	Babeș-Bolyai University
1.2 Faculty	Faculty of Chemistry and Chemical Engineering
1.3 Doctoral school	Chemical Engineering
1.4 Field of study	Chemical Engineering
1.5 Study cycle	Doctorate
1.6 Study program / Qualification	Doctoral training / PhD in Chemical Engineering

2. Course data

2.1 Name of discipline	**Advanced Chemical Engineering – SDIC8111**						
2.2 Teacher responsible for lectures	Prof. PhD Eng. Cormos Calin-Cristian						
2.3 Teacher responsible for seminars	Prof. PhD Eng. Cormos Calin-Cristian						
2.4 Year of study	I	2.5 Semester	1	2.6. Type of evaluation	E	2.7 Course framework	M

3. Estimated total time of teaching activities (hours per semester)

3.1 Hours per week	3	Out of which: 3.2 Lectures	1	3.3 Seminars / Laboratory classes	2
3.4 Total hours in the curriculum	36	Out of which: 3.5 Lectures	12	3.6 Seminars / Laboratory classes	24

Allocation of study time:	
Study supported by textbooks, other course materials, recommended bibliography and personal student notes	60
Additional learning activities in the library, on specialized online platforms and in the field	60
Preparation of seminars / laboratory classes, topics, papers, portfolios and essays	48
Tutoring	43
Examinations	3
Other activities: -	-

3.7 Individual study (total hours)	214
3.8 Total hours per semester	250
3.9 Number of credits	10

4. Preconditions (where applicable)

4.1 Curriculum	• Not the case
4.2 Competences	• Not the case

5. Conditions (where applicable)

5.1 Conducting lectures	• Students will attend the class with their mobile phones closed • The delay will not be accepted
5.2 Conducting seminars / laboratory classes	• 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 the session • For late delivery is penalized with 0.5 points / day • It is forbidden to enter the seminar room with food

6. Specific competences acquired

Professional competences	• Identification and appropriate use of language, concepts, approaches, theories, models and basic methods particular to chemical engineering by highlighting new directions of current development in this field (eg integration and intensification of processes, development of sustainable solutions for industrial processes, etc.). • Explaining and interpreting the operation of (bio) chemical process design, monitoring and automation systems, with and without computer system. • Solving the problems of operation and operation of the integrated assembly: monitoring system, automation system, calculation system and (bio) chemical process. • Evaluation and analysis of the performance of production systems in the field of chemical engineering for the development of sustainable solutions by evaluating the aspects of integration of mass and energy flows and intensification of property transfer processes (mass, energy and impulse). • Implementation of hardware / software solutions for typical and elementary problems of improving chemical process monitoring and automation systems (improvement / introduction of measurement systems, regulation, monitoring, on / off-line data processing). • Use of language and basic knowledge of chemical, mechanical, electrical engineering, systems engineering, sustainable development, management and marketing associated with communication as well as the use of computer means of presentation / information • Explanation and interpretation based on systemic analysis of complex problems present in a (bio) chemical process to understand the interdependencies between chemical, mechanical, electrical and management-marketing systems, which contribute to its manifestation as a whole. • Interdisciplinary, systemic management and from the perspective of sustainable development of the issue of management of (bio) chemical processes established for solving medium difficulty problems, in well-defined contexts; notifying the technical and managerial deficiencies resulting from the lack of coordination and highlighting the possibilities of correction. • Critical-constructive evaluation and analysis of basic methods and practices with reference to management and management and marketing systems, mainly on methods, principles, classification, product comparison, market comparison, identification of malfunctions and non-compliance with legislative restrictions, including from the perspective of sustainable development. • Formulation, development and systemic implementation of solutions for typical and elementary problems of organization, product promotion, image promotion, reorganization, adaptation, cooperation and mutually beneficial association for typical production processes, using computer tools for presentation / information.
Transversal competences	• Execution of professional tasks according to the specified requirements and within the imposed deadlines (with emphasis on modern techniques of working with the computer and PowerPoint presentation of the various technological variants evaluated), respecting the norms of professional ethics and moral conduct, following a predetermined work plan and with qualified guidance. • Solving professional tasks in accordance with the general objectives established by integrating into a working group and distributing tasks to subordinate levels. • Permanent information and documentation in its field of activity in Romanian and in a language of international circulation, using modern methods of information and communication.

7. Course objectives (based on the acquired competencies grid)

7.1 The general objective of the course	• To familiarize students with the basics, concepts, theories and models in the field of chemical engineering and the use of modern techniques for the development of sustainable technological solutions.
7.2 Specific objectives	• Acquisition of basic theoretical knowledge on modern chemical engineering (e.g. aspects of process integration and intensification, assessment of consumption of non-renewable energy and material resources, environmental impact, etc.). • Acquiring knowledge on energy management of industrial processes, assessing aspects of consumption of materials and energy and assessing economic and environmental impact. • Gaining knowledge on the most important directions of development in the field of chemical and process engineering for the development of sustainable solutions.

8. Content

8.1 Lectures	Teaching methods	Comments
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.	Presentation, discussion, case studies, exercises	
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. Technical-economic and environmental assessment (including life cycle analysis) of industrial processes.		
8.1.3. Modern solutions for the intensification of chemical processes in order to develop sustainable solutions with improved technical 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 Seminars / laboratory classes	Teaching methods	Comments
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 synthase 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 analysed 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.		

Bibliography:
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. Aligning the contents of the discipline with the expectations of the epistemic community representatives, professional associations and standard employers operating in the program field

- By mastering the theoretical-methodological concepts and approaching the practical aspects included in the discipline "*Advanced Chemical Engineering*" doctoral students acquire a consistent knowledge, in accordance with the competencies in the Diploma Supplement and the ANC qualifications.

10. Examination

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final grade
10.4 Lectures	Assessment of knowledge	Written exam	100%
	Assessment of knowledge	Ongoing tests	
10.5 Seminars / laboratory classes	Activity during seminars	Discussions, answers to questions	
	Assessment of knowledge	Written exam	
10.6 Minimum performance standard			

- "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.

Date of issue
20.06.2023

Signature of the teacher responsible for lectures
Prof. PhD Eng. Cormos Calin-Cristian

Signature of the teacher responsible for seminars
Prof. PhD Eng. Cormos Calin-Cristian

Date of approval by the doctoral school council
27.06.2023

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

COURSE SYLLABUS

1. Data about the program

1.1 Higher education institution	Babeș-Bolyai University
1.2 Faculty	Faculty of Chemistry and Chemical Engineering
1.3 Doctoral school	Chemical Engineering
1.4 Field of study	Chemical Engineering
1.5 Study cycle	Doctorate
1.6 Study program / Qualification	Doctoral training / PhD in Chemical Engineering

2. Course data

2.1 Name of discipline	**Methodology for elaborating research project in chemical engineering** – SDIC8112						
2.2 Teacher responsible for lectures	Prof. PhD. Eng. Reka BARABAS Prof. PhD. Ana-Maria CORMOȘ						
2.3 Teacher responsible for seminars	Prof. PhD. Eng. Reka BARABAS Prof. PhD. Ana-Maria CORMOȘ						
2.4 Year of study	I	2.5 Semester	1	2.6. Type of evaluation	E	2.7 Course framework	Opt

3. Estimated total time of teaching activities (hours per semester)

3.1 Hours per week	3	Out of which: 3.2 Lectures	1	3.3 Seminars / Laboratory classes	2
3.4 Total hours in the curriculum	36	Out of which: 3.5 Lectures	12	3.6 Seminars / Laboratory classes	24

Allocation of study time:	h
Study supported by textbooks, other course materials, recommended bibliography and personal student notes	48
Additional learning activities in the library, on specialized online platforms and in the field	72
Preparation of seminars / laboratory classes, topics, papers, portfolios and essays	54
Tutoring	36
Examinations	4
Other activities: -	-

3.7 Individual study (total hours)	214
3.8 Total hours per semester	250
3.9 Number of credits	10

4. Preconditions (where applicable)

4.1 Curriculum	• Not the case
4.2 Competences	• Not the case

5. Conditions (where applicable)

5.1 Conducting lectures	• Students will attend the class with their mobile phones closed • The delay will not be accepted
5.2 Conducting seminars / laboratory classes	• Students will attend the seminar with their mobile phones closed • Students attend seminar sessions with the theoretical knowledge necessary to discuss the topic.

6. Specific competences acquired

Professional competences	1. Application of research principles, methods, techniques suited to the research objective, in order to identify concrete solutions to real situations; 2. Carrying out an extensive bibliographical study on the chosen research topic; knowledge of general and specific research methods; 3. Use of the conceptual and methodological research framework for new theoretical approaches; 4. Selection of adequate research methods for a proper interpretation of the results and formulation of relevant conclusions. 5. Use of fundamental and applicative concepts in the development of research projects.
Transversal competences	1. Execution of professional tasks according to the specified requirements and within the imposed deadlines (with emphasis on modern techniques of working with the computer and PowerPoint presentation of the various technological variants evaluated), respecting the norms of professional ethics and moral conduct, following a predetermined work plan and with qualified guidance. 2. Solving professional tasks in accordance with the general objectives established by integrating into a working group and distributing tasks to subordinate levels. 3. Permanent information and documentation in its field of activity in Romanian and in a language of international circulation, using modern methods of information and communication.

7. Course objectives (based on the acquired competencies grid)

7.1 The general objective of the course	• Education in terms of responsibility for research project management; • Conceptual understanding of project management. • Knowledge acquiring related to intellectual property rights
7.2 Specific objectives	• Definition and characteristics of a project • Advantages/disadvantages of using project management • The importance and role of project management • Methodology and tools for developing a project • Requirements for successful project management

8. Content

8.1 Lectures	Teaching methods	Comments
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.		2 h
8.1.3. Programme/project implementation; Analysis of the successful implementation of activities. SWOT analysis; Relationship with funders/ beneficiaries.		2 h
8.1.4. Intellectual property rights. Introductory concepts.		2 h
8.1.5. National patents. OSIM.		2 h
8.1.6.International patents. Drafting patent applications.		2 h

Bibliography:
1. D. Oprea. Project managenent: theory and practice (in Romanian), Ed. Sedcom Libris, Iaşi, 2001.
2. N. Postăvaru, Projects managenent, Ed. Matrix, Bucuresti, 2002.
3. T. Mochal, J. Mochal, Lessons of project management, Ed. CODECS, Bucureşti, 2006.
4. Claudiu Marian Bunãiasu, Elaboration and Management of the projects, Ed. Universitarã, Bucuresti, 2012.

5. Alexandru Cristian Strenc , Bucura Ionescu , Gheorghe Gheorghiu, Patent law., Editura Universul Juridic, 2019		
8.2 Seminars / laboratory classes	Teaching methods	Comments
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.		4 h
8.2.3. Project management.		4 h
8.2.4.National and international patent documentation		4 h
8.2.5. Making national patent applications		4 h
8.2.6. Making patent claims		4 h

Bibliography:

1. D. Oprea. Project managenent: theory and practice, Ed. Sedcom Libris, Iaşi, 2001.
2. N. Postăvaru, Projects managenent, Ed. Matrix, Bucuresti, 2002.
3. T. Mochal, J. Mochal, Lessons of project management, Ed. CODECS, Bucureşti, 2006.
4. Claudiu Marian Bunãiasu, Elaboration and Management of the projects, Ed. Universitarã, Bucuresti, 2012.
5. Alexandru Cristian Strenc , Bucura Ionescu , Gheorghe Gheorghiu, Patent law., Editura Universul Juridic, 2019

9. Aligning the contents of the discipline with the expectations of the epistemic community representatives, professional associations and standard employers operating in the program field

- By mastering the theoretical-methodological concepts and approaching the practical aspects included in the discipline " *Methodology of research project development in chemical engineering* " doctoral students acquire a consistent knowledge, in accordance with the competencies in the Diploma Supplement and the ANC qualifications.

10. Examination

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final grade
10.4 Lectures	Assessment of knowledge Assessment of knowledge	Development of research project.	80%
10.5 Seminars / laboratory classes	Activity during seminars Assessment of knowledge	Discussions, answers to questions	20%
10.6 Minimum performance standard			

- "Satisfactory" grade for the exam according to the scale.
- Knowledge of introductory notions regarding current trends in the field of project development.

Date of issue	Signature of the teacher responsible for lectures	Signature of the teacher responsible for seminars
21.06.2023	Prof. PhD. Eng. Reka Barabas	Prof. PhD. Eng. Reka Barabas
	Prof. PhD. Ana-Maria Cormos	Prof. PhD. Ana-Maria Cormos

Date of approval by the doctoral school council
27.06.2023

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

COURSE SYLLABUS

1. Information regarding the program

1.1 Higher education institution	"Babes-Bolyai" University
1.2 Faculty	Chemistry and Chemical Engineering
1.3 Department	Chemical Engineering
1.4 Field of study	Chemical Engineering
1.5 Study cycle	Doctorat
1.6 Study Programme / Qualification	Doctor/PhD degree in Chemical Engineering

2 Information regarding the discipline

2.1 Name of discipline	**Ethics, professional deontology and intellectual property- SDIC 8113**						
2.2 Course coordinator			Prof. habil. dr. ing. Graziella Liana TURDEAN				
2.3 Seminar coordinator			Prof. habil. dr. ing. Graziella Liana TURDEAN				
2.4 Year of study	I	2.5 Semester	1	2.6. Type of evaluation	E	2.7 Type of discipline	Obl

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

3.1 Hours per week	3	Of which: 3.2 course	1	3.3 seminar/l**aboratory**	2
3.4 Total hours in the curriculum	36	Of which: 3.5 course	12	3.6 seminar/laboratory	24
Time allotment:					ore
Learning using manual, course support, bibliography, course notes					64
Additional documentation (in libraries, on electronic platforms, field documentation)					48
Preparation for seminars/labs, homework, papers, portfolios and essays					60
Tutorship					40
Evaluations					2
Other activities: not the case					-

3.7 Total individual study hours	214
3.8 Total hours per semester	250
3.9 Number of ECTS credits	10

4. Prerequisites (if necessary)

4.1. curriculum	• Not the case
4.2. competencies	• Not the case

5. Conditions (if necessary)

5.1. for the course	• The students will turn off their mobile phones • Delays will not be tolerated
5.2. for the seminar /lab activities	• Students will turn off their mobile phones during the seminar. • Students come to the seminar sessions having acquired the theoretical knowledge necessary to discuss the topic, as well as the necessary supplies (pocket calculators, pencils, erasers, rulers). • Access to food inside the seminar room is prohibited.

6. Specific competencies acquired

Profesional competencies	1. Learning and respecting the ethical principles of scientific research. 2. Use of concepts, legislation in force, and principles specific to the field of intellectual property.
Transversal competencies	1. The ability to think systemically, holistically, critically, argumentatively, and creatively; the ability to analyze and solve with originality the problems of ethics and professional deontology.

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

7.1 General objective of the discipline	• Acquiring, knowing, understanding, assimilating, and assuming deontological norms in the academic research activity in the field of Chemical Engineering.
7.2 Specific objective of the discipline	• Developing respect for the authentic moral values of humanity. • Formation of the ability to use the value judgments of modern ethics and deontology. • Formation of the capacity for critical evaluation in the educational/research activity and the moral state of the persons/research groups. • Understanding the importance of respecting intellectual property in responsible scientific research.

8. Contents

8.1 Course	Teaching method	Remarks
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; explication; 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 rules and etiquette in the academic space).	lecture; explication; conversation; description; problematization; debate.	2 h
8.1.3. Institutional tools for promoting academic ethics (Legislative framework, codes, ethics commissions. How do we have a critical discussion in a civilized way? University etiquette).	lecture; explication; conversation; description; problematization; debate.	2 h
8.1.4. Scientific research and originality of research results and scientific works. The normative framework of scientific research. Ethical codes in scientific research. Deviations from good conduct in scientific research.	lecture; explication; conversation; description; problematization; debate.	2 h
8.1.5. Challenges and dilemmas (Academic freedom and disagreement in science). Are there public responsibilities of members of the academic community?	lecture; explication; 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. The ethics of intellectual property.	lecture; explication; conversation; description; problematization; debate.	2 h

References

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. Mureşan, M. Constantinescu, Etică și integritate academică, Editura Universităţii din Bucureşti, 2018.
6. E. E. Ștefan, Etica si integritate academica, Editura ProUniversitaria, Bucuresti, 2018.

8.2 Seminary	Teaching method	remarks
8.2.1. Interdisciplinary and integrative approaches.	Explication; Conversation; Description; Problematization.	4 h
8.2.2. Professional responsibility in the universities and research institutes	Explication; Conversation; Description; Problematization.	4 h
8.2.3. Institutional tools for promoting academic ethics. Examples, case studies.	Explication; Conversation; Description; Problematization.	4 h
8.2.4. The application of the concepts of ethics and integrity in the elaboration of the doctoral thesis. The case study regarding the originality of the experimental data.	Explication; Conversation; Description; Problematization.	4 h
8.2.5. Precautionary principle and risky research.	Explication; Conversation; Description; Problematization.	4 h
8.2.6. Intellectual property. The ethics of intellectual property	Explication; Conversation; Description; Problematization.	4 h

Bibliografie

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. Mureşan, M. Constantinescu, Etică și integritate academică, Editura Universităţii din Bucureşti, 2018.
6. E. E. Ștefan, Etica si integritate academica, Editura ProUniversitaria, Bucuresti, 2018.

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations, and representative employers within the field of the program

- By instructing the theoretical and practical concepts of **SDIC 8113 - Ethics, professional deontology and intellectual property** course, the students will get the knowledge in accordance with the required competencies from the Diploma supplement and ANC's qualifications.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Understanding the processes discussed. The specificity of the answers. Holistic thinking and approach.	Realization, presentation, and support of the drafted research project and (b) of the case study regarding the originality of the experimental data.	80%

		Answers to questions related to solving real problems. Appeals are resolved by the discipline holder. Fraud in the preparation of the project is punishable by expulsion, according to the ECST regulation of UBB.	
10.5 Seminar	Understanding the processes discussed. The specificity of the answers. Holistic thinking and approach.	Preparation and transmission to the instructor of the various control topics.	20%
	The ability to use different sources of information.		
10.6 Minimum performance standards			
• 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.			

Date
21.06.2023

Signature of the course coordinator
Prof. habil. dr. ing. Graziella L. Turdean

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

Date of approval at SDIC level
27.06.2023

Signature of the head of Doctoral School in Chemical Engineering (SDIC)
Prof. habil. dr. ing. Mircea Vasile Cristea

COURSE SYLLABUS

1. Data about the program

1.1 Higher education institution	Babeș-Bolyai University
1.2 Faculty	Faculty of Chemistry and Chemical Engineering
1.3 Doctoral school	Chemical Engineering
1.4 Field of study	Chemical Engineering
1.5 Study cycle	Doctorate
1.6 Study program / Qualification	Doctoral training / PhD in Chemical Engineering

2. Course data

2.1 Name of discipline	**Technologies for capture and using CO2 applied in high polluting industrial processes – SDIC8114**						
2.2 Teacher responsible for lectures	Prof. PhD Eng. Cormos Calin-Cristian						
2.3 Teacher responsible for seminars	Prof. PhD Eng. Cormos Calin-Cristian						
2.4 Year of study	I	2.5 Semester	1	2.6. Type of evaluation	E	2.7 Course framework	Opt

3. Estimated total time of teaching activities (hours per semester)

3.1 Hours per week	3	Out of which: 3.2 Lectures	1	3.3 Seminars / Laboratory classes	2
3.4 Total hours in the curriculum	36	Out of which: 3.5 Lectures	12	3.6 Seminars / Laboratory classes	24

Allocation of study time:	
Study supported by textbooks, other course materials, recommended bibliography and personal student notes	60
Additional learning activities in the library, on specialized online platforms and in the field	60
Preparation of seminars / laboratory classes, topics, papers, portfolios and essays	48
Tutoring	43
Examinations	3
Other activities: -	-

3.7 Individual study (total hours)	214
3.8 Total hours per semester	250
3.9 Number of credits	10

4. Preconditions (where applicable)

4.1 Curriculum	• Not the case
4.2 Competences	• Not the case

5. Conditions (where applicable)

5.1 Conducting lectures	• Students will attend the class with their mobile phones closed • The delay will not be accepted
5.2 Conducting seminars / laboratory classes	• 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 the session • For late delivery is penalized with 0.5 points / day • It is forbidden to enter the seminar room with food

6. Specific competences acquired

Professional competences	• Identification and appropriate use of language, concepts, approaches, theories, models and basic methods for the evaluation of carbon dioxide capture and use (CCUS) systems applied to different polluting industrial processes. • Explaining and interpreting the operation of systems for monitoring and automating the processes of capture and use of carbon dioxide integrated in polluting industrial processes (e.g. energy production, metallurgy, cement, petrochemicals, etc.). • Solving the problems of operation and operation of the integrated assembly: monitoring system, automation system, calculation system and (bio) chemical process. • Evaluation and analysis of the performance of automation systems (transducers, execution elements, regulators, protection systems) and monitoring (software and hardware) in the integrated process-monitoring / automation system, in order to identify solutions to improve their performance. • Implementation of hardware / software solutions for typical and elementary problems of improving industrial process monitoring and automation systems with an emphasis on energy conversion with CO_2 capture and use. • Use of language and basic knowledge of mechanical, electrical, energy engineering, systems engineering, sustainable development, management and marketing associated with communication as well as the use of computer means of presentation / information. • Explanation and interpretation based on systemic analysis of complex problems present in a (bio) chemical process to understand the interdependencies between chemical, mechanical, electrical and management-marketing systems, which contribute to its manifestation as a whole. • Interdisciplinary, systemic management and from the perspective of sustainable development of the issue of reducing greenhouse gas (CO_2) emissions generated by the processes of conversion of energy from fossil fuels and other polluting industrial applications (eg metallurgy, cement, petroleum). chemistry etc.). • Critical-constructive evaluation and analysis of basic methods and practices with reference to management and management and marketing systems, mainly on methods, principles, classification, product comparison, market comparison, identification of malfunctions and non-compliance with legislative restrictions, including from the perspective of sustainable development. • Formulation, development and systemic implementation of solutions for typical and elementary problems of organization, product promotion, image promotion, reorganization, adaptation, cooperation and mutually beneficial association for typical production processes, using computer tools for presentation / information.
Transversal competences	• Execution of professional tasks according to the specified requirements and within the imposed deadlines (with emphasis on modern techniques of working with the computer and PowerPoint presentation of the various technological variants evaluated), respecting the norms of professional ethics and moral conduct, following a predetermined work plan and with qualified guidance. • Solving professional tasks in accordance with the general objectives established by integrating into a working group and distributing tasks to subordinate levels. • Permanent information and documentation in its field of activity in Romanian and in a language of international circulation, using modern methods of information and communication.

7. Course objectives (based on the acquired competencies grid)

7.1 The general objective of the course	• To acquaint students with the basic notions, concepts, theories and models in the field of carbon capture and use technologies applied to different polluting industrial processes.
7.2 Specific objectives	• Acquisition of basic theoretical knowledge on carbon dioxide capture and use technologies (CCUS). • Acquiring knowledge on energy management of polluting industrial processes, evaluation of aspects of energy consumption, CO_2 emissions and evaluation of capital and operating costs. • Gain knowledge of the most important energy conversion systems, capture, use and storage of carbon dioxide, modelling and simulation of energy conversion systems and various chemical processes.

8. Content

8.1 Lectures	Teaching methods	Comments
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 decarbonized energy vectors (eg 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.		
Bibliography: 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 Seminars / laboratory classes	Teaching methods	Comments
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 CO2 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 CO2 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.		
Bibliography: 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. Aligning the contents of the discipline with the expectations of the epistemic community representatives, professional associations and standard employers operating in the program field

- By mastering the theoretical-methodological concepts and approaching the practical aspects included in the discipline "*CO_2 capture and utilization technologies applied to polluting industrial processes*" doctoral students acquire a consistent knowledge, in accordance with the competencies in the Diploma Supplement and the ANC qualifications.

10. Examination

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final grade
10.4 Lectures	Assessment of knowledge	Written exam	100%
	Assessment of knowledge	Ongoing tests	
10.5 Seminars / laboratory classes	Activity during seminars	Discussions, answers to questions	
	Assessment of knowledge	Written exam	
10.6 Minimum performance standard			

- "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.

Date of issue
21.06.2023

Signature of the teacher responsible for lectures
Prof. PhD Eng. Cormos Calin-Cristian

Signature of the teacher responsible for seminars
Prof. PhD Eng. Cormos Calin-Cristian

Date of approval by the doctoral school council
27.06.2023

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

COURSE SYLLABUS

1. Data about the program

1.1 Higher education institution	Babeș-Bolyai University
1.2 Faculty	Faculty of Chemistry and Chemical Engineering
1.3 Doctoral school	Chemical Engineering
1.4 Field of study	Chemical Engineering
1.5 Study cycle	Doctorate
1.6 Study program / Qualification	Doctoral training / PhD in Chemical Engineering

2. Course data

2.1 Name of discipline	SDIC8115 Advanced Process Engineering Control						
2.2 Teacher responsible for lectures	Prof.dr.ing. Cristea V. Mircea						
2.3 Teacher responsible for seminars	Prof.dr.ing. Cristea V. Mircea						
2.4 Year of study	I	2.5 Semester	1	2.6. Type of evaluation	E	2.7 Course framework	Opt.

3. Estimated total time of teaching activities (hours per semester)

3.1 Hours per week	3	Out of which: 3.2 Lectures	1	3.3 Seminars / Laboratory classes	2
3.4 Total hours in the curriculum	36	Out of which: 3.5 Lectures	12	3.6 Seminars / Laboratory classes	24
Allocation of study time:					
Study supported by textbooks, other course materials, recommended bibliography and personal student notes					64
Additional learning activities in the library, on specialized online platforms and in the field					48
Preparation of seminars / laboratory classes, topics, papers, portfolios and essays					60
Tutoring					40
Examinations/presentations					2
Other activities: -					

3.7 Individual study (total hours)	214
3.8 Total hours per semester	250
3.9 Number of ECTS credits	10

4. Preconditions (where applicable)

4.1 Curriculum	• Basic knowledge on chemical process control
4.2 Competences	• General competences on using computer software for solving systems of algebraic and differential equations (Matlab/Simulink), and on feedback control systems using PID controllers

5. Conditions (where applicable)

5.1 Conducting lectures	• Study of the course topic
5.2 Conducting seminars / laboratory classes	• Preparation of the seminar works • Obtaining minimal grade for the seminar homeworks

6. Specific competences acquired

Professional competences	• Capacity of conceiving, designing and simulating the control system dedicated to a specific chemical process; • Capacity of elaborating and calibrating a mathematical model of high complexity dedicated to a certain specific process, for control purposes; • Capacity of choosing an appropriate advanced control solution based on the process model, as a result of the dynamic and steady state analysis of a chemical/biochemical process; • Ability to develop a model predictive control application; • Capacity of operating a chemical plant based on the monitoring and control systems
Transversal competences	• Ability of approaching chemical plants based on system thinking, holistic thinking, critical thinking, in and argumentative way and problem solving orientation; • High level of computer skills, analysis of a process based on a mathematical model.

7. Course objectives (based on the acquired competencies grid)

7.1 The general objective of the course	• Learning by PhD students of methods, techniques and knowledge of tools specific to the design of advanced automatic control systems; their application with the involvement of some elements of originality
7.2 Specific objectives	• Development of an advanced control system, suitable for a complex chemical process

8. Content

8.1 Lectures	Teaching methods	Comments
8.1.1. Discrete systems behaviour description tools; their use in process control using computer systems. *Basic concepts, keywords*: sampling and reconstruction of continuous signals, Z transform and Z transfer function, design of discrete controllers.	Presentation, Simulation using computers, Interactive exercises, Discussions, Case studies	PowerPoint presentations, Matlab/Simulink and Toolboxes for applications 2h
8.1.2. Advanced process contrpl based on mathematical models. Model Predictive control. *Basic concepts, keywords:* Analytical models and models based on experimental data ("white / gray / black-box"), design of model-based control systems.	Presentation, Simulation using computers, Interactive exercises, Discussions, Case studies	PowerPoint presentations, Matlab/Simulink and Toolboxes for applications 4h
8.1.3. Optimal process control. *Basic concepts, keywords*: steady and dynamic state optimal control; control of continuous and discrete processes.	Presentation, Simulation using computers, Interactive exercises, Discussions, Case studies	PowerPoint presentations, Matlab/Simulink and Toolboxes for applications 2h
8.1.4. Multivariable control of complex chemical processes. *Basic concepts, keywords*: decentralized and centralized multivariable control, decoupling, tuning.	Presentation, Simulation using computers, Interactive exercises, Discussions, Case studies	PowerPoint presentations, Matlab/Simulink and Toolboxes for applications 1h

8.1.5. Fuzzy controllers. *Basic concepts, keywords*: fuzzification, logical inference, unfuzzyfication, design of fuzzy control systems.	Presentation, Simulation using computers, Interactive exercises, Discussions, Case studies	PowerPoint presentations, Matlab/Simulink and Toolboxes for applications 1h
8.1.6. Controllers using artificial neural networks (ANNs). *Basic concepts, keywords*: predictive control according to nonlinear ANNs models, design of ANN based control systems.	Presentation, Simulation using computers, Interactive exercises, Discussions, Case studies	PowerPoint presentations, Matlab/Simulink and Toolboxes for applications 1h
8.1.7. Plantwide control. *Basic concepts, keywords*: control strategies, primary and secondary controlled variables, top-down and down-top hierarchical design approach.	Presentation, Simulation using computers, Interactive exercises, Discussions, Case studies	PowerPoint presentations, Matlab/Simulink and Toolboxes for applications 1h

Course bibliography

1. V. M. Cristea, S. P. Agachi, Elemente de Teoria Sistemelor, Editura Risoprint, Cluj-Napoca, 2002,
2. Paul Şerban Agachi, Mircea Vasile Cristea, Alexandra Ana Csavdári, Botond Szilágyi, Advanced Process Engineering Control, De Gruyter Publishing House, Editura De Gruyter GmbH, Berlin, 2016,
3. Agachi P.S., Cristea M.V, Basic Process Engineering Control, Editura 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.

Supplementary bibliography

5. F. Greg Shinskey - 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: the titles can be accessed at the Library of the Chemical Engineering Department, at the Faculty of Chemistry and Chemical Engineering extension of the Central University Library "Lucian Blaga" and at the Library of the Technical University of Cluj-Napoca.

8.2 Seminars / laboratory classes	Teaching methods	Comments
8.2.1. Description of the discrete systems behaviour. Examples. *Basic concepts, keywords*: Applications related to the Z transform and the Z transfer function, the design and tuning of discrete controllers.	Seminar, discussions, exercises, simulation using computers, Individual study topic	*Student obligations*: reading the course and the related bibliography 4h
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 tuning of the controllers (drying of electrical insulators, fluid catalytic cracking unit, counteracting river pollution).	Seminar, discussions, exercises, simulation using computers, Individual study topic	*Student obligations*: reading the course, the related bibliography and solving the topic 8h
8.2.3. Optimal process control. Examples and applications. *Basic concepts, keywords*: Optimal control applications; designing and tuning controllers;	Seminar, discussions, exercises, simulation using computers,	*Student obligations*: reading the course, the related bibliography and solving the topic

regulation, stability (controlling the operation of the wastewater treatment plant, control of the temperature in exothermic reactors, pH control in a cascade of reactors).	Individual study topic	4h
8.2.4. Multivariable control of complex chemical processes. Examples and applications. *Basic concepts, keywords*: Comparison between decentralized and centralized control (applications), design and tuning the controllers (fluid catalytic cracking unit, wastewater treatment plant, CO_2 absorption in MEA).	Seminar, discussions, exercises, simulation using computers, Individual study topic	*Student obligations*: reading the course, the related bibliography and solving the topic 2h
8.2.5. Fuzzy control. Examples and applications. *Basic concepts, keywords*: Applications for the design of fuzzy control systems (temperature control, humidity control when drying electrical insulators, catalyst inventory control in fluid catalytic cracking plant).	Seminar, discussions, exercises, simulation using computers, Individual study topic	*Student obligations*: reading the course, the related bibliography and solving the topic 2h
8.2.6. Controllers using artificial neural networks (ANNs). Examples and applications. *Basic concepts, keywords*: Predictive control applications based on nonlinear ANN models, design and tuning of ANN based control systems (fluid catalytic cracking unit, wastewater treatment plant, alcoholic fermentation reactor)	Seminar, discussions, exercises, simulation using computers, Individual study topic	*Student obligations*: reading the course, the related bibliography and solving the topic 2h
8.2.7. Plantwide control systems. Examples. *Basic concepts, keywords*: down-top and top-down hierarchical design approach (fluid catalytic cracking unit).	Seminar, discussions, exercises, simulation using computers, Individual study topic	*Student obligations*: reading the course, the related bibliography and solving the topic 2h

Bibliography:

1. Paul Şerban Agachi, Mircea Vasile Cristea, Alexandra Ana Csavdári, Botond Szilágyi, Advanced Process Engineering Control, De Gruyter Publishing House, Editura De Gruyter GmbH, Berlin, 2016,
2. Mihaela Iancu, P.Ş.Agachi, M.Mogoş, 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.

Supplementary 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. Aligning the contents of the discipline with the expectations of the epistemic community representatives, professional associations and standard employers operating in the program field

- The curriculum was developed after consultation with research groups from the universities of Iasi, Bucharest, Ploiesti and Timisoara.

10. Examination

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final qualification
10.4 Lectures	Assessment of gained knowledge Understanding the processes discussed Specificity of the answers Holistic thinking and approach	Presentation of a project work	80%
10.5 Seminars / laboratory classes	Assessment of gained knowledge and activity during seminars Understanding the processes discussed Specificity of the answers Holistic thinking and approach	Discussions, answers to questions, examinations during the seminar	10%
	Ability to use different sources of information	Examinations during the seminar	10%
10.6Minimum performance standard			
• The qualification "Satisfactory" in the exam according to the scale.			

Date of issue	Signature of the teacher responsible for lectures	Signature of the teacher responsible for seminars
20.06.2023	Cristea V.M.	Cristea V.M.

Date of approval by the doctoral school council

27.06.2023

Signature of the doctoral school director

Prof. dr. eng. Vasile Mircea Cristea

COURSE SHEET

1. Data about the program

1.1 Higher education institution	Babeș-Bolyai University
1.2 Faculty	Faculty of Chemistry and Chemical Engineering
1.3 Doctoral school	Chemical Engineering
1.4 Field of study	Chemical Engineering
1.5 Study cycle	Doctorate
1.6 Study program / Qualification	Doctoral training / Doctor of Chemical Engineering

2. Course data

2.1 Name of discipline				Research methods in electrochemical engineering			
2.2 Teacher responsible for lectures				Prof. Emeritus dr. eng. Petru ILEA			
2.3 Teacher responsible for seminars				Prof. Emeritus dr. eng. Petru ILEA			
2.4 Year of study	1st	2.5 Semester	1	2.6. Type of evaluation	E	2.7 Course framework	Opt

3. Estimated total time of teaching activities (hours per semester)

3.1 Hours per week	3	Out of which: 3.2 Lectures	1	3.3 Seminars / Laboratory classes	2
3.4 Total hours in the curriculum	36	Out of which: 3.5 Lectures	12	3.6 Seminars / Laboratory classes	24
Allocation of study time:					hours
Study supported by textbooks, other course materials, recommended bibliography and personal student notes					64
Additional learning activities in the library, on specialized online platforms and in the field					48
Preparation of seminars / laboratory classes, topics, papers, portfolios and essays					60
Tutoring					40
Examinations					2
Other activities					-

3.7 Individual study (total hours)	214
3.8 Total hours per semester	250
3.9 Number of credits	10

4. Preconditions

4.1 Curriculum	Basic elements of thermodynamics and electrochemical kinetics
4.2 Competențeces	General skills for making electrochemical experimental installations and conducting experiments with the computer

5. Conditions (where applicable)

5.1 Conducting lectures	-
5.2 Conducting seminars / laboratory classes	Students will present themselves in the lab in a lab coat Students may not leave an operating facility unattended

6. Specific competences acquired

Professional competences	• Definition of basic notions, concepts, theories, and models in the field of electrochemical engineering and their appropriate use in professional communication • Use of basic knowledge in the field of electrochemical engineering to explain and interpret phenomena specific to electrochemical technologies. • Identification and application of concepts, methods and theories to solve problems typical of electrochemical engineering. • Critical analysis and use of working principles, methods and techniques for quantitative and qualitative evaluation of electrochemical processes. • Application of fundamental concepts and theories in the field of electrochemical engineering for the development of research projects
Transversal competences	• The execution of professional tasks according to the specified requirements, within the imposed deadlines, in compliance with the rules of professional ethics and moral conduct, following a predetermined work plan • Permanent information and documentation in its field of activity in Romanian and in an international language, with the use of modern methods of information and communication

7. Course objectives

7.1 The general objective of the course	• PhD students' knowledge of basic notions, concepts, theories and applications specific to electrochemical engineering research
7.2 Specific objectives	• Acquiring basic theoretical knowledge regarding electrochemical research methods • Acquiring knowledge related to the manipulation of experimental and IT equipment specific to electrochemical engineering research. • Acquiring the methods of processing experimental data and their interpretation

8. Content

8.1 Lectures	**Teaching methods**	**Comments**
8.1.1. Fundamentals of Electrochemistry and Electrochemical Engineering	Presentation Explanation Conversation Description Debate	Materials used: PowerPoint presentations
8.1.2. Classification of methods for investigating an electrode process		
8.1.3. Theory and applications of potentiostatic and galvanostatic methods		
8.1.4. Experimental methods under conditions of controlled movement of the electrolyte		
8.1.5. Techniques for determining mass transport parameters in an electrochemical reactor		
8.1.6. Electrochemical reactor design		

Bibliography

1. L. Oniciu, P. Ilea, Ionel Cătălin Popescu, „Electrochimie tehnologică", Casa Cărţii de Ştiinţă, Cluj-Napoca, 1995
2. L. Oniciu, Liana Mureşan, „Electrochimie aplicată", Presa Universitară Clujeana, 1998.
3. P. Ilea, „Electrosinteze anorganice", Casa Cărţii de Ştiinţă, Cluj-Napoca, 2006
4. F. Goodridge, K. Scott, Electrochemical procces engineering: „A Guide to the design of electrolytic plant", Plenum, New York, London, 1995
5. N. Vaszilcsin, Maria Nemes, L. Oniciu, P. Ilea, „Electrochimie - aplicaţii numerice", Editura Politehnica, Timişoara, 1999
6. C M. A. Brett and A. M. Oliveira Brett, Electrochemistry principles, Methods, and Applications, 1992, 1992, Oxford University Press

8.2 Seminars / Laboratory classes	Teaching methods	Comments
8.2.1. Calculations for the evaluation of parameters specific to electrochemical processes (electrode potential, alternating current density, overpotential, limiting current density, mass transport coefficient, etc.)	Explication Conversation Experimental demonstration Individual calculus topics	Student obligations: Reading the course and related bibliography.
8.2.2. Performing laboratory experiments based on potentiostatic and galvanostatic methods and interpreting the results		
8.2.3. Carrying out method-based laboratory experiments under conditions of controlled electrolyte movement and interpreting the results		
8.2.4. Carrying out method-based laboratory experiments under conditions of controlled electrode movement and interpreting the results		
8.2.5. Performing laboratory experiments based on techniques for determining mass transport parameters in an electrochemical reactor and interpreting the results		
8.2.6. The design based on the mass and electrical energy balance of an electrochemical reactor specific to the doctoral thesis		

Bibliography

1. L. Oniciu, P. Ilea, Ionel Cătălin Popescu, „Electrochimie tehnologică", Casa Cărții de Știință, Cluj-Napoca, 1995 L. Oniciu, Liana Mureșan, „Electrochimie aplicată", Presa Universitară Clujeana, 1998.
2. P. Ilea, „Electrosinteze anorganice", Casa Cărții de Știință, Cluj-Napoca, 2006
3. F. Goodridge, K. Scott, Electrochemical procces engineering: „A Guide to the design of electrolytic plant", Plenum, New York, London, 1995
4. N. Vaszilcsin, Maria Nemes, L. Oniciu, P. Ilea, „Electrochimie - aplicații numerice", Editura Politehnica, Timișoara, 1999
5. L. Oniciu şi alții, Lucrări practice de electrochimie şi tehnologii electrochimice ", Univ. "Babeș- Bolyai ", 1993 (ediția II).L. Oniciu, Liana Mureșan, Electrochimie aplicată, Presa Universitară Clujeana, 1998

9. Aligning the contents of the discipline with the expectations of the epistemic community representatives, professional associations and standard employers operating in the program field

- The curriculum was developed after consultation with research groups from the universities of Bucharest and Timișoara.
- By acquiring the theoretical and practical concepts specific to research methods in electrochemical engineering, doctoral students will be able to carry out a high-performance scientific research activity in accordance with the skills required for the possible occupations provided in ANC.

10. Examination

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final grade
10.4 Lectures, Seminars / laboratory classes	The correctness of the answers - the acquisition and correct understanding of the issues covered in the course. Correct problem solving The quality of the report and prepared projects The activity carried out at the seminar	Access to the exam is conditional on attendance at the course and seminar / laboratory activities. The report will be presented in front of the course owner. It will be graded with a grade between: "Very good", "Good", "Satisfactory" and "Unsatisfactory" depending on the attendance at the didactic activities, the content of the final report and the manner of its presentation.	100 %
10.5 Minimum performance standard			
The qualification "Satisfactory" in the exam according to the scale. Knowledge of fundamental and applied notions of electrochemical processes			

Date of issue

Signature of the teacher responsible for lectures

Signature of the teacher responsible for seminars

22.06.2023

Prof. Emeritus dr. eng. Petru ILEA

Prof. Emeritus dr. eng. Petru ILEA

Date of approval by the doctoral school council

Signature of the doctoral school director

27.06.2023

Prof. dr. eng. Vasile Mircea CRISTEA