

## COURSE DESCRIPTION

### Electrochemical Sensors and Biosensors

Academic year 2026 - 2027

#### 1. Programme-related data

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

#### 2. Course-related data

2.1. Course title	<b>Electrochemical Sensors and Biosensors</b>			Course code	<b>CME6232</b>
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	I	2.5. Semester	1	2.6. Type of assessment	Progress check
2.7. Course status	Optional			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. <del>seminar</del> / laboratory/ <del>project</del>	2
3.4. Total of hours in the curriculum	56	of which: 3.5. course	28	3.6. <del>seminar</del> / laboratory	28
<b>Time allocation for individual study (IS) and self-taught activities (ST)</b>					<b>hours</b>
Learning from textbooks, course materials, bibliography, and notes (IS)					40
Additional research in the library, on subject-specific electronic platforms, and on-site					14
Preparing seminars/ laboratories/ projects, assignments, reports, portfolios, and essays					10
Tutoring (professional guidance)					3
Examinations					2
Other activities					-
<b>3.7. Total hours of individual study (IS) and self-taught activities (ST)</b>				<b>69</b>	
<b>3.8. Total hours per semester</b>				<b>125</b>	
<b>3.9. Number of credits</b>				<b>5</b>	

#### 4. Prerequisites (where applicable)

4.1. curriculum-related	
4.2. skills-related	

#### 5. Specific conditions (where applicable)

5.1. course-related	Not the case
5.2. seminar/laboratory-related	Not the case

### 6.1. Competencies resulting from the completion of the degree programme (as referred to in the curriculum)<sup>1</sup>

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 apparatus 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.
PC5	Identifying and defining a research theme in the field of chemical engineering process, elaboration and implementation of a plan for achieving the objectives proposed and valuing the scientific research results obtained.
PC6	quality and resource management in process engineering by applying the systemic approach and the principles of longterm development.
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	Planning, monitoring, and assuming the duties of a subordinate professional group. Demonstrating the capacity of coordination, analytical thinking, adaptability and flexibility, collaboration with team members.
TC3	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)<sup>2</sup>

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

### 7. Subject-specific learning outcomes

Knowledge and comprehension
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<sup>1</sup> 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.

<sup>2</sup> 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.

1. The student can design, plan and carry out activities in the field of electroanalytical methods within a laboratory for analysis.
<b>Specific academic skills</b>
1. The student can coordinate activities in the field of electroanalytical methods within a laboratory for analysis.

## 8. Contents

8.1. Course	Teaching and learning methods	Remarks <sup>3</sup>
8.1.1. Introduction related to the history of the development of electrochemical sensors. General characteristics of the sensors. The methodology of using sensors.	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.2. General characteristics of the sensors (continuation). The methodology of using sensors.	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.3. Potentiometric sensors based on solid membrane. Glass electrode.	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.4. Potentiometric sensors based on a solid membrane. Electrode based on LaF <sub>3</sub> monocrystal membrane, Electrode based on silver sulfide and metal sulfides (Ag <sub>2</sub> S-MeS) membranes. Electrode based on silver sulfide and halides silver membrane (Ag <sub>2</sub> S-AgX).	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.5. Potentiometric sensor based on a liquid membrane.	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.6. Ion-selective electrode based on field-effect transistors (FET, MOSFET).	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.7. Potentiometric gas sensors. Electrode for CO <sub>2</sub> detection, type Severinghaus	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.8. Potentiometric electrode based on ceramics for the detection of gases at high temperature	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.9. Amperometric sensors. Generalities. Investigation techniques of the amperometric electrode	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.10. Amperometric sensors for oxygen detection (Clark electrode).	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.11. Enzyme-based electrochemical biosensors (biological receptor, immobilization techniques, enzyme heterogeneous kinetics, K <sub>M</sub> , I <sub>max</sub> , linearization, inhibition types). Generation of biosensors.	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.12. Enzyme-based electrochemical biosensors for the detection of glucose. Continuous glucose monitoring <i>in vivo</i> , miniaturisation.	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.13. Enzyme-based electrochemical biosensors for the detection of lactate, cholesterol, creatinine, etc. Enzyme-based electrochemical biosensors for the detection of choline, heavy metals, or based on enzyme inhibition.	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.14. Immunobiosensors	Presentation; Explanation, Conversation; Description; Debate	2 h

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

Bibliography		
1. Turdean G. L., Sarmiza S.E., Popescu I. C., Biosenzori amperometrici. Teorie si aplicatii, Presa Universitara Clujeana, Cluj-Napoca, 2005. 2. Popescu I. C., Senzori electrochimici, Litografia UBB, 1996. 3. Fraden Jacob (ed), Handbook of modern sensors. Physics, designs, and applications, Springer, 2004 4. Kékedy L., Senzori electrochimici metalici si ioni, Ed. Academiei, Bucuresti, 1987. 5. 5 Turdean G. L., Prezentare PP actualizat anual, 50 slide/sedinta de curs.		
<b>8.2. Laboratory</b>	<b>Teaching and learning methods</b>	<b>Remarks</b>
8.2.1. Instructions for working safety in laboratory. Do a graphics: statistical errors. Hazardous reagents, use of electroanalytical equipment. Law " <i>Ordinul nr. 339/16.08.1996</i> ".	Explanation, Conversation; Description; Debate	4h
8.2.2. Determination of selectivity coefficient of an ion-selective electrode. Applying of standard addition method.	Explanation, Conversation; Description; Debate	4h
8.2.3. Determination of the buffering capacity of a solution	Explanation, Conversation; Description; Debate	4h
8.2.4. Amperometric sensor for oxygen detection: calibration, response time.	Explanation, Conversation; Description; Debate	4h
8.2.5. Characterization of an amperometric biosensor for glucose detection	Explanation, Conversation; Description; Debate	4h
8.2.6 - 8.2.7. Seminar: exercises and problems	Explanation, Conversation; Description; Debate; Problem solving	8h
Bibliography		
1. Popescu I.C., Turdean G.L., Nicoara A., Ilea P., Muresan L., Lucrari practice pentru ciclul de studii aprofundate in "Electrochimie aplicata", lito UBB, Cluj-Napoca, 1997. 2. Oniciu L., Popescu I.C., Ilea P., Muresan L., Rus E.M., Gyenge E., Madaras M., Nicoara A., Muresan C., Lucrari practice de Electrochimie si tehnologii electrochimice, lito UBB, Cluj-Napoca, 1993.		

## 9. Evaluation




























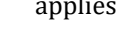
Type of activity	9.1 Evaluation criteria <sup>4</sup>	9.2 Evaluation methods <sup>5</sup>	9.3 Percentage in the final grade
9.4. Course	Correctness of answers – proper understanding and learning of concepts discussed during lectures.	Examination method: The Progress check consists of a discussion about solving the theoretical subjects/exercises proposed by the course responsible, on the scheduled date. The access to the Progress check is conditioned by the presentation of the laboratory reports corresponding to all the practical works. The intention to defraud the Progress check is punishable by elimination	80%
	Correct use of learned concepts within new contexts.		

<sup>4</sup> 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.

<sup>5</sup> Both final evaluation methods and ongoing evaluation strategies should be established.

		from the exam, according to the ECST rules of UBB.	
9.5. Seminar/ laboratory	Correctness answers, assimilation, and understanding of the concepts discussed during seminars The quality of prepared reports The work was undertaken in the laboratory	Examination method: The reports with the interpretation of results obtained during laboratory experiments are taught at the latest next week from the laboratory session. The intention of plagiarism of the laboratory report is punishable by restricting access to the Progress check examination.	20%
9.6 Minimum standard for passing			
<ul style="list-style-type: none"> <li>Minimum grade 5 (five) at the Progress check examination and minimum grade 6 at practical activities (laboratory + seminar).</li> <li>Knowledge of the concepts used; description of the operating principle of a bio/sensor; solving problems for the application/explaining a real situation.</li> </ul>			

## 10. SDG labels (Sustainable Development Goals)<sup>6</sup>

		Sustainable Development Generic Label						
								
								No label applies
								

Date of entry

The 11<sup>th</sup> of April 2026

Signature of the 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 department

The 11<sup>th</sup> of April 2026

Signature of the head of the department

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

<sup>6</sup> 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."