

# 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	Master
1.6 Study programme / Qualification	Advanced Chemical Process Engineering / Master’s degree in Chemical Engineering

## 2. Information regarding the discipline

2.1 Name of the discipline	<b>Electrochemical sensors and biosensors - 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 evaluation	C	2.7 Type of discipline	Optional

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

3.1 Hours per week	4	Of which: 3.2 course	2	3.3 seminar/ <b>laboratory</b>	2
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 seminar/laboratory	28
Time allotment:					hours
Learning using manual, course support, bibliography, course notes					40
Additional documentation (in libraries, on electronic platforms, field documentation)					14
Preparation for seminars/labs, homework, papers, portfolios and essays					10
Tutorship					3
Evaluations					2
Other activities: not the case					-
3.7 Total individual study hours	69				
3.8 Total hours per semester	125				
3.9 Number of ECTS credits	5				

## 4. Prerequisites (if necessary)

4.1. curriculum	<ul style="list-style-type: none"> <li>Not the case</li> </ul>
4.2. competencies	<ul style="list-style-type: none"> <li>Not the case</li> </ul>

## 5. Conditions (if necessary)

5.1. for the course	<ul style="list-style-type: none"> <li>The students will turn off their mobile phones</li> <li>Delays will not be tolerated</li> </ul>
5.2. for the seminar /lab activities	<ul style="list-style-type: none"> <li>Students will attend the seminar with information from the course notes corresponding to the current seminar/lab topic</li> <li>Students will turn off their mobile phones</li> <li>Delays will not be tolerated</li> </ul>

## 6. Specific competencies acquired

<b>Professional competencies</b>	<ul style="list-style-type: none"> <li>• Doing analytical and physico-chemical experiments with higher difficulty degree and interpretation of results.</li> <li>• Identification, characterization, and comparison of different instrumental techniques applicable in chemical and biochemical determinations.</li> <li>• Conducting experiments in view to determine the physico-chemical properties of specific compounds, processing, and interpretation of obtained data.</li> <li>• Using an integrated complex instrumental technique and its adjustment to new software products in order to apply them in specific analysis.</li> <li>• Using appropriate uni- and multivariate analysis techniques in the evaluation of physico-chemical properties.</li> <li>• Applying innovative concepts, theories, and advanced physico-chemical techniques to solve a specific research topic.</li> </ul>
<b>Transversal competencies</b>	<ul style="list-style-type: none"> <li>• independent execution of complex professional duties and research projects using computer-aided techniques and compliance with professional ethics and morals.</li> <li>• Planning, monitoring, and assuming professional duties of underline group. Proving the coordination capabilities, analytical thinking, adaptability and flexibility, collaboration with team members.</li> <li>• Self-assessment of professional performances and establish the needs of continuous learning, documentation in the work fields in correlation with the labour market.</li> </ul>

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

7.1 General objective of the discipline	<ul style="list-style-type: none"> <li>• The course provides theoretical and practical information about the devices and equipment necessary into applications in the bio/medical electro-analytical chemistry field</li> <li>• Obtaining theoretical knowledge about methods and stages of realization, the characterization of different types of electrochemical sensors and interpretation from analytical/kinetically point of view of the obtained responses.</li> <li>• Correlation of fundamental notions of analytical chemistry, kinetics, electrochemistry, biology, physiology, biochemistry, technology, and marketing applied in the bio/medical field.</li> </ul>
7.2 Specific objective of the discipline	<ul style="list-style-type: none"> <li>• Habituate the students with the newest information about electro-analytical methods for monitoring analytes in the bio/medical field using electrochemical sensors and biosensors.</li> <li>• Presentation of the construction, operating principle and working conditions or features of potentiometric, amperometric, conductimetric bio/sensors, underlying the determination methods of some important analytes.</li> <li>• Highlighting the latest analytical performance of each class of bio/sensors when used for the analytical detection of species.</li> </ul>

## 8. Content

8.1 Course	Teaching methods	Remarks
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.	Presentation; Explanation,	2 h

Glass electrode.	Conversation; Description; Debate	
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 detection of gases at high temperature	Presentation; Explanation, Conversation; Description; Debate	2 h
8.1.9. Amperometric sensors. Generalities. Investigation techniques of 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

## References

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. Turdean G. L., Prezentare PP actualizat anual, 50 slide/sedinta de curs.

8.2 Laboratory/Seminar	Teaching methods	Remarks
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		4h
8.2.6 - 8.2.14. Seminar: exercises and problems	Explanation, Conversation; Description; Debate; Problem solving	4h
<b>References</b> <ol style="list-style-type: none"> <li>1. Popescu I.C., Turdean G.L., Nicoara A., Ilea P., Muresan L., <i>Lucrari practice pentru ciclul de studii aprofundate in "Electrochimie aplicata"</i>, lito UBB, Cluj-Napoca, <b>1997</b>.</li> <li>2. Oniciu L., Popescu I.C., Ilea P., Muresan L., Rus E.M., Gyenge E., Madaras M., Nicoara A., Muresan C., <i>Lucrari practice de Electrochimie si tehnologii electrochimice</i>, lito UBB, Cluj-Napoca, <b>1993</b>.</li> </ol>		

## 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

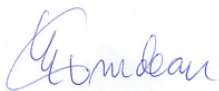
- By instructing the theoretical and practical concepts of **Electrochemical sensors and biosensors** course, the students will get the knowledge in accordance with required competencies from Diploma supplement and ANC's qualifications.

## 10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	<p>Correctness of answers – proper understanding and learning of concepts discussed during lectures. Correct use of learned concepts within new contexts.</p> <p>Correct solving of problems as an inherent part of examination subjects.</p>	<p><b><u>On-site or online examination method:</u></b></p> <p>The colloquy consists of a discussion about solving the theoretical subjects/exercises proposed by the course responsible, on the scheduled date. The access to the colloquy is conditioned by the presentation of the laboratory reports corresponding to all the practical works.</p> <p>The intention to defraud the colloquy is punishable by elimination from the exam, according to the ECST rules of UBB.</p>	80%
10.5 Seminar/lab activities	<p>Correctness answers, assimilation, and understanding of the concepts discussed during seminars</p> <p>The quality of prepared reports</p> <p>The work was undertaken in the laboratory</p>	<p><b><u>On-site or online examination method:</u></b></p> <p>The reports with the interpretation of results obtained during laboratory experiments are taught at the latest next week from the laboratory session.</p> <p>The intention of plagiarism of the laboratory report is punishable by restricting access to the colloquy.</p>	20%
10.6 Minimum performance standards			
<ul style="list-style-type: none"> <li>➤ Minimum grade 5 (five) at the written exam, 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 problem for application/explaining of a real situation.</li> </ul>			

**Date**  
April 8, 2021

**Signature of the course coordinator**



Prof. habil. dr. ing. Graziella L. Turdean

**Signature of seminar coordinator**

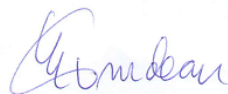


Prof. habil. dr. ing. Graziella L. Turdean

**Date of approval**

April 8, 2021

**Signature of the head of department**



Prof. habil. dr. ing. Graziella L. Turdean