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| **Basic data of the subject** | | | |
| **Academic Unit:** | **Department of Chemistry, Faculty of Mathematics & Natural Sciences** | | |
| **Course title:** | **Electrochemistry** | | |
| **Level:** | **Master** | | |
| **Course status:** | **Mandatory** | | |
| **Study year:** | **I (first)** | | |
| **Number of hours per week:** | **2+2** | | |
| **Credit value – ECTS:** | **6** | | |
| **Time / location:** | **Will be appointed by the Department** | | |
| **Lecturer:** | **Prof. Dr. Ramë VATAJ** | | |
| **Contact details:** | **Email:** [rame.vataj@uni-pr.edu/](mailto:rame.vataj@uni-pr.edu/)  **Tel:** /038-229-964/ | | |
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| **Course description:** | In this course the theoretical foundations of electrochemical dynamics are learnt, ranging from chemical and physical processes that occur at the interface solution – electrode, faradic and nonfaradic processes, the mechanism of electron transfer on the electrode, Butler-Volmer equation, Fick’s law, electrode reaction mechanisms, and electrochemical methods which are used in electrochemical kinetics. | | |
| **Course objectives:** | The module is prepared for the purpose of giving to the students of chemistry and chemical engineering, fundamental information on theoretical and practical use of electrochemistry. Students will learn about electrochemical techniques which can be used to study the reactions of different mechanisms, and also in qualitative and quantitative analytical studies. All electrochemical applications based on basic principles of electrochemistry. | | |
| **Learning outcomes:** | After completing this module, students will be able to:   * Understand and have basic knowledge of dynamic electrochemistry. * To have basic knowledge on the processes which take place at the electrodes, the mechanism of development of these processes and equations related to these processes. * Use electrochemical methods in monitoring the mechanisms of chemical reactions; * To recognize the modern electrochemical techniques and know the advantages and disadvantages in relation to each other and in relation to other physical and chemical methods (e.g. Spectroscopic methods). | | |
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| **Contribution on student load (must correspond with learning outcomes)** | | | |
| **Activity** | **Hours** | **weeks** | **Total** |
| Lectures | 2 | 15 | 30 |
| Exercise theoretical/laboratory | 2 | 15 | 30 |
| Contact with lecturer/consultations | 1 | 15 | 15 |
| Tests, seminars | 2 | 2 | 4 |
| Homework | 1 | 10 | 10 |
| Student self-engagement (at the library or at home) | 2 | 10 | 20 |
| Final preparation for the exam | 2 | 15 | 30 |
| Time spent on evaluation (tests, quiz, final exam) | 2 | 5 | 10 |
| Projects, presentations, etc. | 2 | 3 | 6 |
| **Total** |  |  | **150** |
| **Teaching methods:** | Lecture, seminar, discussion, group work. | | |
| **Evaluation methods:** | * The first evaluation: 15% * The second evaluation 15% * Engaging in exercises 15% * Regular attendance 5% * Final exam 50% | | |
| **Literature** | | | |
| **Basic Literature:** | 1. A. Bard, L. Faulkner, “Electrochemical Methods”, second edition, John Wile and Sons. | | |
| **Additional Literature:** | 1. P. Zanello, “Inorganic Electrochemistry”, RSC,  Cambridge, UK, 2003.  2. A. J. Bard, M. Stratmann, “Encyclopedia of  Electrochemistry”, Wiley-VCH GmbH & Co.  KgaA, Weinheim, 2003. | | |

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| **Designed study plan:** | |
| **Week** | **Lectures which will be held** |
| ***First week:*** | Introduction to dynamic electrochemistry.  Faradic and nonfaradic processes, electrical double layer, its capacity. |
| ***Second week:*** | Factors that affect the rate of the electrode reactions in faradic processes.  The mechanism of electron transfer at the electrode. |
| ***Third week*:** | Butler-Volmer equation. Standard rate constant. Transfer coefficient. Exchange current. |
| ***Fourth week:*** | Potential-current intensity equation. Tafel's equation. The effects of mass transfer on electrodes. |
| ***Fifth week:*** | The mass transfer through migration and diffusion. The effect of the addition of supporting electrolyte. |
| ***Sixth week*:** | Fick’s laws and the solutions of diffusion equations. |
| ***Seventh week:*** | Marcus's theory of electron transfer. The reorganization energy.  **First mid-term evaluation.** |
| ***Eighth week:*** | Mechanisms of multi stage electrode reactions. |
| ***Ninth week:*** | Electrochemical methods that are used in electrode kinetics. |
| ***Tenth week:*** | Polarography and pulse voltammetry. |
| ***Eleventh week*:** | Differential Pulse Voltammetry (DPV), Square Wave Voltammetry (SWV). |
| ***Twelfth week* :** | Hydrodynamic techniques. Rotating Electrode Voltammetry. |
| ***Thirteenth week*:** | Cyclic Voltammetry (CV). |
| ***Fourteenth week*:** | Spectroelectrochemistry. Electrolytic techniques (electrolysis) |
| ***Fifteenth week*:** | **Second mid – term evaluation**. |
| **Week** | **Exercises which will be held** |
| ***First week:*** | Electrochemical cells. |
| ***Second week:*** | Overvoltage. Electrolysis of water. |
| ***Third week:*** | Measurement of diffusion coefficient of electrochemically active substance towards the surface of the electrode. |
| ***Fourth week:*** | Linear voltammetry of potassium ferricyanide solution on a static and a dynamic electrode. |
| ***Fifth week:*** | Tafel’s plots construction for a redox couple. |
| ***Sixth and seventh week:*** | Cyclic voltammetry of potassium ferricyanide aqueous solution and the analysis of the voltammogram obtained. |
| ***Eighth and ninth week:*** | Pulse differential voltammetry of potassium ferricyanide aqueous solution and the analysis of data. |
| ***Tenth and eleventh week:*** | Electrochemical chlorine production on a small scale. |
| ***Twelfth week:*** | The study of stages of redox reaction by cyclic voltammetry. |
| ***Thirteenth week:*** | Electro-organic synthesis. |
| ***Fourteenth week:*** | Hydrodimerisation of acrylonitrile. |
| ***Fifteenth week:*** | **Evaluation test** |

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| **Academic policies and rules of conduct:** |
| Attendance at lectures and exercises should be regular and scheduled time. Students must be in commensurate to the general rules of the university. For specific rules and specifics of organizing lectures and exercises, students are notified by the professor of the course. |