**SYLLABUS**

**Spring semester 2022-2023 academic years**

**on the educational program «*Actual problems of electrochemical technologies of active metals*»**

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| **Discipline’s code** | **Discipline’s title** | **Independent work of students (IWS)** | **No. of hours per week** | | | | **Number of credits** | **Independent work of student with teacher (IWST)** |
| **Lectures (L)** | **Practical training (PT)** | | **Laboratory (Lab)** |
| APETAM 7302 | Actual problems of electrochemical technologies of active metals | 98 | 15 | 30 | | - | 7,5 | 7 |
| **Academic course information** | | | | | | | | |
| **Form of education** | **Type of course** | **Types of lectures** | | | **Types of practical training** | | **Form of final control** | |
| Full-time | Descriptive, Analytical | Problematic, analytical, educational | | | Problem solving, laboratory work | |
| **Lecturer** | PhD Malchik Fyodor | | | | | | Exam  (project) | |
| **e-mail** | [frodo-007@mail.ru](mailto:frodo-007@mail.ru) | | | | | |
| **Telephone number** | +77072442236 | | | | | |

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| **Aim of the course** | **Expected Learning Outcomes (LO)** \*  As a result of studying the discipline the undergraduate will be able to: | **Indicators of LO achievement (ID)**  (for each LO at least 2 indicators) |
| **Aim of the course:** to form the ability of thinking and designing products/processes/software within the framework described by the new paradigms of chemical and physical-chemical engineering. | 1) Understand the nature of processes at the phase boundary of active metals, accompanied by charge transfer | 1.1 use of basic concepts and terms to describe processes in electrochemistry |
| 1.2 know the features of the processes at the phase boundary of active metals. |
| 2) Explain the nature of all regularities and laws of electrochemical thermodynamics and kinetics | 2.1 Know and be able to substantiate the main conclusions of relationships and dependencies in electrochemistry. |
| 2.2 classify electrochemical processes according to the main features and nature of the course |
| 3) Analyze and predict processes on active metals and patterns of charge transfer. | 3.1 methodology for taking into account the features and analysis of electrochemical processes on active metals |
| 3.2 Conduct analysis, highlight the stages of the process and offer quantitative relationships and a description of the causes of processes on active metals. |
| 4) Systematize main regularities of electroplating of active metals Apply electrochemical methods of analysis of active metals | 4.1 Explains the main features of electrolysis and electroplating. |
| 4.2 Explains applicability of active metals in industry |
| 4.3 Know and be able apply basic electrochemical methods of analysis of active metals |
| 5) Estimate and explain main principle of active metal application in battery technology | 5.1 Finds and explains examples of lithium and sodium batteries. |
| 5.2 Explains the main features of applicability earth alkaline metals in battery technology |
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| **Prerequisites** | Undergraduate studies in Chemistry or Chemical Engineering are of benefit | |
| **Post requisites** | Physical chemistry; chemical Technology; metrology, standardization, certification; specialist. disciplines in electrical technology, educational and research work of students | |
| **Information resources\*\*** | **Literature:\*\***  **References**   1. Antropov L.I. Theoretical electrochemistry. - M., 1984 2. Damaskin B.B.. Electrochemistry.- M., 2008 3. Christian Julien • Alain Mauger • Ashok Vijh • Karim Zaghib «Lithium BatteriesScience and Technology» SBN 978-3-319-19108-9 (eBook)б DOI 10.1007/978-3-319-19108-9 4. C. K. Mann and K. K. Barnes, Electrochemical Reactions in Non-Aqueous Systems (Marcel Dekker, 1970 ) 5. Stender, V.V. Applied electrochemistry.- Kharkov, 1961. 6. Thomas Wenzel «Electrochemical Methods of Analysis» https://asdlib.org/activelearningmaterials/files/2015/08/electrochemical\_text.pdf 7. Cheng, F, “*Functional Materials for Rechargeable Batteries*”, *Advanced Materials*, **2011**, 23, 1695-1715. 8. Bálint Simon, Saskia Ziemann, Marcel Wei Potential metal requirement of active materials in lithium-ion battery cells of electric vehicles and its impact on reserves: Focus on Europe // Resources, Conservation and Recycling, Volume 104, Part A, November 2015, Pages 300-310, https://doi.org/10.1016/j.resconrec.2015.07.011   **Internet resources:**   1. <https://www.youtube.com/@echemchannel9316/videos> 2. <https://www.allthescience.org/what-is-an-active-metal.htm> 3. <http://chemistry-chemists.com/Uchebniki/Chemistry-books-UnChem.html>   Other/further resources will be provided by the teacher during the semester. | |

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| **Academic policy of the course in the context of university moral and ethical values** | **Academic Behavior Rules:**  All students are required to register for the MOOC. The deadlines for completing the modules of the online course must be strictly observed in accordance with the schedule for studying the discipline. Leave in case of current MOOC or SPOC courses.  **ATTENTION!** Failure to meet deadlines results in loss of points! The deadline for each task is indicated in the calendar (schedule) for the implementation of the content of the training course, as well as in the MOOC. Leave in case of current MOOC or SPOC courses.  **Academic values:**  - Practical trainings/laboratories, IWS should be independent, creative.  - Plagiarism, forgery, cheating at all stages of control are unacceptable.  - Students with disabilities can receive counseling *via* e-mail |
| **Evaluation and attestation policy** | **Criteria-based evaluation:**  assessment of learning outcomes in relation to descriptors (verification of the formation of competencies in midterm control and exams).  **Summative evaluation:** assessment of work activity in an audience (at a webinar); assessment of the completed task. |

**CALENDAR (SCHEDULE) THE IMPLEMENTATION OF THE COURSE CONTENT:**

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| week | Topic name | Number of hours | Max.  score\*\*\* |
| **Module 1**  **Fundamentals of equilibrium at the boundary, features of a double layer on active metals** | | | |
| 1 | **Lec 1.** The emergence of the subject of electrochemistry of active metals, as a special section. | 1 | 3 |
| 1 | **Sem 1.** Formation of a double electric layer on the interface, causes and conditions. | 1 | 4 |
| 1 | **Sem 2.** Safety precautions when performing electrochemical laboratory work. | 1 | 4 |
| 2 | **Lec 2.** The concept of metal activity in the framework of ideas about chemical affinity, electronegativity and the theory of acids and bases | 1 | 3 |
| 2 | **Sem 3.** The position of active metals from the point of view of the theory of acids and bases of Usanovich. | 1 | 4 |
| 2 | **Sem 4.** Measurements in non-aqueous media - electrodes and instruments. | 1 | 4 |
| 2 | **IWST 1. Consultation on the implementation of SIW1 on the topic: Types of potential jumps, equilibrium conditions.** | 1 | 5 |
| 3 | **Lec 3.** Formation of a double electric layer at the interface, causes and conditions | 1 | 3 |
| 3 | **Sem 5.** Techniques working with Glove Box - Measurement Methods | 1 | 4 |
| 3 | **Sem 6.** Techniques working with Glove Box – safety measurements. | 1 | 4 |
| 3 | **SIW 1. Types of potential jumps, equilibrium conditions.** |  | 9 |
| 4 | **Lec 4.** Thermodynamic and kinetic characteristics of equilibrium at the surface boundary | 1 | 3 |
| 4 | **Sem 7.** Electrochemical reactions on electrodes and chemical transformation | 1 | 4 |
| 4 | **Sem 8.** Preparation of solutions and electrodes for working with a lithium electrode. | 1 | 4 |
|  | **IWST 2. Lithium metal in battery technology** | 1 | 5 |
| 5 | **Lec 5.** Electronic and ionic equilibrium, their special role for active metals. | 1 | 3 |
| 5 | **Sem 9.** Solvated electron, metal solutions | 1 | 4 |
| 5 | **Sem 10.** Real examples of solvated electron | 1 | 4 |
| 6 | **Lec 6.** Corrosion, passivation by reaction products of active metal with electrolyte | 1 | 4 |
| 6 | **Sem 11.** Types of electrode polarization. Polarization characteristic, reversibility of the electrode process. | 1 | 4 |
| 6 | **Sem 12.** Obtaining polarization characteristics on lithium in propylene carbonate solutions | 1 | 4 |
| 7 | **Lec 7.** Formation of a primary corrosion film, regularities; Secondary corrosion film, diffusion mode of formation. | 1 | 3 |
| 7 | **Sem 14.** Processing and presentation of experimental data | 1 | 4 |
| 7 | **Sem 15.** Preparation of solutions and electrodes for working with sodium electrode | 1 | 4 |
| 7 | **IWST 3. Consultation on the implementation of the IWS 2. Reference electrodes in non-aqueous media Types of electrodes** | 1 | 3 |
|  | **LEVEL CONTROL 1** |  | **100** |
|  | **Module 2**  **Theoretical Foundations of the Electrochemical Features of Active Metals** |  |  |
| 8 | **Lec 8.** Evans Chart for Active Metals | 1 | 3 |
| 8 | **Sem 16.** Theoretical Foundations of the Electrochemical Features of Active Metals | 1 | 3 |
| 8 | **Sem 17.** Galvanostatic method of analysis in battery technology | 1 | 4 |
| 8 | **SIW 2. Reference electrodes in non-aqueous media Types of electrodes** |  | 5 |
| 9 | **Lec 9.** Parabolic law of corrosion film growth | 1 | 3 |
| 9 | **Sem 18.** Preparation of solutions and electrodes for working with a magnesium electrode – part 1 | 1 | 3 |
| 9 | **Sem 19.** Preparation of solutions and electrodes for working with a magnesium electrode – part 2 | 1 | 3 |
| 10 | **Lec 10** Polarization characteristics of active metals; The structure of corrosion films on metals and the correspondence to it of the laws of charge transfer | 1 | 3 |
| 10 | **Sem 20.** Evans chart | 1 | 3 |
| 10 | **Sem 21.** obtaining polarization characteristics on magnesium in propylene carbonate solutions | 1 | 3 |
| 10 | **IWST 4. Colloquium (Essay). Electrochemical methods of analysis** | 1 | **7** |
| 11 | **Lec 11** Features of lithium electrochemistry | 1 | 3 |
| 11 | **Sem 22.** Non-aqueous solvents, reference electrodes | 1 | 3 |
| 11 | **Sem 23.** Preparation of solutions and electrodes for working with an aluminum electrode | 1 | 3 |
| 12 | **Lec 12.** Features of the electrochemistry of other alkali metals | 1 | 3 |
| 12 | **Sem 24.** Precipitation of metals in non-aqueous media | 1 | 3 |
| 12 | **Sem 25.** obtaining polarization characteristics on aluminum in propylene carbonate solutions | 1 | 3 |
| 12 | **IWST 5. Consultation on the implementation of the IWS 3 : Features of corrosion of active metals** | 1 | 4 |
| 13 | **Lec 13** Overview of behavior in electrolytes based on different solvents. | 1 | 3 |
| 13 | **Sem 26.** Features of the electrochemistry of nanoobjects | 1 | 3 |
| 13 | **Sem 27.** Study of Corrosion of Active Metals by Micropolarization of Surface Films | 1 | 3 |
| 13 | **SIW 3** **Features of corrosion of active metals** | 1 | 4 |
| 14 | **Lec 14** Features of the electrochemistry of alkaline earth metals | 1 | 3 |
| 14 | **Sem 28.** Electrochemical alloying | 1 | 3 |
| 14 | **Sem 29.** Study of Corrosion of Active Metals by Micropolarization of Surface Films | 1 | 3 |
|  | **IWST 6. Colloquium (Presentation). Modelling of electrochemical sistem** | 1 | 5 |
| 15 | **Lec 15** Features of the electrochemistry of metals of the 3rd group. | 1 | 3 |
| 15 | **Sem 30.** Novel approaches in active method electroplating. | 1 | 4 |
| 15 | **Sem 31.** Novel electroanalytical equipment. | 1 | 4 |
| 15 | **IWST 7. Consultation on examination issues** | 1 | 0 |
|  | **LEVEL CONTROL 2** |  | **100** |

Dean \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **A.K. Galeyeva**

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Description automatically generatedHead of Department \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **A. M. Argimbayeva**

Lecturer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **F.I. Malchik**

**NOTE:**

The total volume of the syllabus is no more than 5 pages, font 10, Times New Roman

\* LO is based on cognitive (1-2), functional (2-3), systemic (1-2) competencies, total 4-7.

The types and number of competencies (out of 5) are compiled according to the level of education.

\*\* Give no more than 5-7 sources of literature (full bibliographic description), in depth for the last 10 years. (in exceptional cases, 20-30% of irreplaceable classical textbooks), for natural directions - 10 years. Humanitarian direction -5 years

Literature and resources:

1. Basic literature

2. Additional reading

3. Software

4. Internet resources

5. Professional databases

\*\*\*Spreading the assessment of students' knowledge is at the discretion of the compilers of the syllabus.