Basic Information:
Course Title: **FUNDAMENTALS OF ELECTROCHEMISTRY**
Lecturer: Prof. DSc Vessela Tsakova
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Total Teaching Hours: 30

Annotation (up to 150 words)

The aim of the course is to introduce the basic theoretical concepts related to thermodynamics and kinetics of electrochemical processes and the properties of electrolyte solutions. The second part of the course emphasizes basic modern measurement techniques in electrochemistry that enable the preparation and characterization of electroactive materials, including the monitoring of processes during electrochemical phase formation. Methods suitable for elucidating the mechanism of electrochemical reactions and for research in the field of electrocatalytic and electroanalytical applications are discussed. The course is focused on practically useful knowledge that enables a thorough understanding of the capabilities of electrochemical methods and their successful application in various fields of materials science.

The course is intended for graduate and doctoral students, as well as professionals working in the fields of electrochemistry, electrocatalysis, electroanalysis, physical chemistry, and materials science.

Course content (brief description by topics or modules) Topic / Module I:
Module 1: Basic Concepts in Electrochemistry
1. Electrical conductivity, strong and weak electrolytes, concepts of pH and buffer solutions.
2. Double electric layer.
3. Electrochemical potential, electrode potential. Nernst equation. Reference electrodes.
4. Overpotential, galvanic cell voltage, open-circuit potential.
5. Rate-limiting steps of the electrochemical reaction – electron transfer across the phase boundary. Butler-Volmer equation.
6. Rate-limiting steps in electrochemical reactions – mass transport. Cottrell equation.
7. Rate-limiting steps in electrochemical reactions – side reactions, adsorption.
8. Initial stages of the electrochemical formation of a new phase.
9. Limiting factors in the electrochemical growth of a new phase.

Module 2: Electrochemical methods for investigating phenomena at the electrode/electrolyte interface
10. Potentiostats, chronoamperometry, chronopotentiometry
11. Rotating disk electrode. Galvanostatic measurements.
12. Cyclic voltammetry – experimental studies.
13. Cyclic voltammetry – theoretical concepts.
14. Differential pulse methods.
15. Electrochemical quartz microbalance.

Teaching and assessment methods

- in-person lecture course
- assessment by tests

Competencies acquired as a result of training (3-5 points):

- basic theoretical knowledge of the thermodynamics and kinetics of electrochemical processes
- use of electrochemical methods for characterizing electroactive materials
- application of electrochemical techniques for electroanalytical measurements

Literature:

1. Electrochemistry, The Basics With Examples, Christine Lefrou, Pierre Fabry, Jean-Claude Poignet, Springer, 2012.
2. Electrochemical Methods, Fundamentals and Applications, A.J. Bard & L.R. Faulkner, J.Wiley&Sons Inc., 2001.
3. Electrochemistry, Carl Hamann, Andrew Hamnett, Wolf Vielstich, Wiley-VCH, 1998.
4. Электрохимия, Б.Б. Дамскин, О.А. Петрий, Г.А. Цирлина, Химия, Москва, 2006.
5. Lehrbuch der Elektrochemie, Gunther Wittstock, Wiley VCH, Weinheim, 2023.
6. Handbook of electrochemistry, ed. C. G. Zoski, Elsevier, 2007.

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