KE2110 Applied Electrochemistry 7.5 credits

Tillämpad elektrokemi

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for KE2110 valid from Autumn 2017

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Chemical Science and Engineering,Chemistry and Chemical Engineering

Specific prerequisites

Admission requirements for programme students at KTH:
At least 150 credits from grades 1, 2 and 3 of which at least 110 credits from years 1 and 2, and bachelor's work must be completed, within a programme that includes:
75 university credits (hp) in chemistry or chemical engineering, 20 university credits (hp) in mathematics and 6 university credits (hp) in computer science or corresponding.

Admission requirements for independent students:
75 university credits (hp) in chemistry or chemical engineering, 20 university credits (hp) in mathematics and 6 university credits (hp) in computer science or corresponding. Documented proficiency in English corresponding to English B.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

After completion of the course you should be able to:

Explain the concepts electrod potential, cell potential and current density, and to describe hoe the cell potential of an electrochemical cell is built up by its components during rest and under load. Calculate cell potential and electrode potential for electrochemical systems at equilibrium.

Describe theories for the structure of the electrochemical double layer and double layer capacitance.

Explain and implement relationships between current density and electrode potential. Implement these relationships to compute either current density or electrode potential from data, and to extract kinetic parameters from polarization data and to. Extract kinetic parameters from polarization data.

Describe mechanisms of and relationships for mass transfer in electrolytes, and to explain the concepts of limiting current density and Nernst diffusion layer. Explain and implement relationships between current density and electrode potential under conditions of mixed mass transport and kinetic control.

Use the concept of rate determining steps to explain the kinetics for multi electron reactions, e.g. hydrogen evolution and copper deposition, and qualitatively explain the relationship between adsorption energy and catalytic activity.

Use the concept of mixed potential to analyze, for example, cases of electrochemical corrosion.

Formulate models for calculation of primary and secondary current distribution in electrochemical cells with flat electrodes. Perform qualitative predictions based upon given conditions. Solve a fairly advanced and realistic current distribution problems using COMSOL or similar software.

Describe the design and function of porous gas diffusion electrodes. Describe the theories for porous electrodes and apply the macro homogenous model on current distribution problems without variation of concentrations

Describe the operating principle for the different types of fuel cells, the most common types of batteries and super capacitors as well as the major electrolytical processes

Analyse, discuss and perform calculations for applied electrochemical systems, such as fuel cells, batteries and electrolytic processes based upon the course contents. Discuss comparative and efficiency figures of merit for such systems

Describe some electrochemical experimental methods such as; cyclic voltammetry, recording polarisation curves, and potential and galvano static step experiments. Perform simple electrochemical experiments such as current and potential measurements for a three-electrode cell. Perform qualitative and quantitative evaluation of data from the course laboratory or similar experiment.

These objectives are meant to correspond to grade A.

Course contents

The electrochemical double layer, electrode kinetics, mass transfer in electrochemical systems, electrocatalysis. Design of electrochemical reactors, current distribution. Survey of electrochemical processes and power sources.

Experimental techniques.

Course literature

Electrochemistry, 2nd edition, by C.H. Hamann, A. Hamnett, W. Vielstich, Wiley-VCH (2007).

Handout from D. Pletcher and F. Walsh, Industrial Electrochemistry, Chapman and Hall Ltd, 1990, p. 385-404.

Summary of mathematical formulae, TEK 2010.

Exercises and solved examples, TEK 2014.

Current distribution in cells and porous electrodes, TEK 2010

Examination

- LAB1 - Laboratory Course, 1.5 credits, grading scale: P, F
- TEN1 - Written exam, 4.5 credits, grading scale: A, B, C, D, E, FX, F
- ÖVN1 - Homework, 1.5 credits, grading scale: P, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Other requirements for final grade

Passed examination TEN1, 4,5 credits.
Laboratory work including written reports (LAB1), 1,5 credit.
Homework assignments and one group assignment (ÖVN1), 1,5 credit.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.