Teaching electrochemical resources and its implementation during the COVID-19 pandemic

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Abstract

Currently, two basic courses focused on electrochemical sources are offered at the CTU in Prague, FEE. One in the bachelor's stage, this is a shared course with the basics of photovoltaics and one in the master's stage, this is a separate course with an hourly allowance of 2 + 2 (2 hours of lectures, and 2 hours of exercises) for 14 weeks. At the time of the greatest restrictions associated with the COVID-19 pandemic, it was necessary to adjust this concept so that students can also carry out practical measurements.

Keywords: teaching electrochemical sources; COVID-19 pandemic

INTRODUCTION

Currently, two basic courses focused on electrochemical sources are offered at the CTU in Prague, FEE. One in the bachelor's stage, this is a shared course with the basics of photovoltaics and one in the master's stage, this is a separate course with an hourly allowance of 2 + 2 (2 hours of lectures, and 2 hours of exercises) for 14 weeks. At the time of the greatest restrictions associated with the COVID-19 pandemic, it was necessary to adjust this concept so that students can also carry out practical measurements.

COURSE CONCEPT

Students of the basic (bachelor's course) are required to have a basic understanding of the principles of energy storage, followed by the technological basics of battery production. The course is logically divided into the basics of basics and components (both PV and batteries), then photovoltaic systems and battery systems are presented, and finally their combinations, as well as economic and environmental aspects of both photovoltaics and operation of electrochemical sources. The course ends with an exam, which tests both the photovoltaic and battery parts.

In the master's course, the acquired skills are deepened, however, completing the bachelor's course is not a prerequisite.

The first part of the course explains electrochemistry as a science and students are introduced to the basics of electrochemical reactions. Next part is an analysis of battery requirements followed by several lectures focused on specific types of batteries (primary, secondary acid, alkaline and lithium). In cooperation with the neighbouring University of Chemistry and Technology, the topics of redox battery systems and fuel cells are presented. Next part is a presentation of the issue of battery protection and operation (BMS design). The next lecture deals with electromobility and storage systems for RES. The course ends again with economic - ecological issues of battery systems.

The teaching also includes laboratory exercises, here we follow a proven lesson scheme. Introductory presentation of the results of the previous measurement to the students, followed by a short discussion of the task and then the measurement itself. Students are divided into 2 groups of a maximum of 5 students. Thus, the teaching of laboratories takes place with a staff of one instructor for 10 students.

DISTANCE LEARNING & IT SUPPORT

The MOODLE system is used to support teaching for long time. MS TEAMS was used preferentially during the COVID pandemic. We evaluate the MOODLE system as a better support for full-time teaching, while MS TEAMS is a support for distance learning.

During the COVID lockdown, the entire semester was implemented remotely. The lectures took place online. The lecturer lectured mostly from the home-office. Students were motivated to attend the lecture, but were provided with a record of study. These were non-public records for which no further use is expected. The exercises then took place in masse (for the whole study group). The syllabus of the exercises was modified with regard to the possibility of conducting experiments directly by students at home.

Students bought or supplemented their home equipment with components at a price of approximately 12 EUR:

- Arduino UNO module
- 2 relays
- basic set of resistors and
- cell holder (type AA).

The assigned tasks first introduced the students to the Arduino system and then the students performed simple measuring tasks.

1) Discharge of the primary cell (AA) with intermittent load and recording to the PC

2) Measurement of internal resistance by the method of two currents

3) Construction of own BMS - short-circuit current limitation, relay switching in case of overvoltage and undervoltage.

The tasks were supplemented by an analysis of the primary cell and several theoretical tasks using LT SPICE (simulation of replacement cell diagrams) and search tasks of individual types of batteries.

In both the online and full-time courses, students are advised to draw on the Linden's Handbook of Batteries [1] in addition to the available Internet resources.

CONCLUSION

The classic form of teaching was adjusted to home exercises which can be provided by students.

Last year, distance learning was evaluated positively by students. The final exam took place by video call with the teacher.

REFERENCES

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