ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

CdL Advanced Automotive Engineering
A.A. 2019-2020

86461 - ELECTROMECHANCHEMICAL ENERGY STORAGE AND CONVERSION

6 Credits (60 hours)

Objectives

- Learn the fundamentals of cell electrochemistry, the materials characteristics and main issues related to the manufacturing process.
- Classify the possible cell chemistry and technology in relation to the range of application in the automotive sector.
- Learn modelling methodology for representing the cell output characteristic and the variability of cell parameters.
- Understanding main issues related to the pack formation by series/parallel connection of cells.
- Learn the sizing criteria for a battery pack.
- Understanding the most innovative electrochemical storage technology.
- Learn the fundamental principle and sizing method for energy storage systems not based on electrochemical batteries: supercapacitors and flywheel.

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86461 - ELECTROMECHANCHEMICAL ENERGY STORAGE AND CONVERSION

6 Credits (60 hours)

The course is divided in two modules:

MODULE 1 - Prof. Francesca Soavi *(3 CFU - 30 hours)*
Electrochemistry of energy storage and conversion cells

Office hours

from Monday to Friday 9:00-13:00 e 14:30-18:30 in Via San Giacomo 7 (LEME) after request by Ph call or email (051 2099797, francesca.soavi@unibo.it)

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LEME
Laboratory of Electrochemistry of Materials for Energetics
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86461 - ELECTROMECHANCHEMICAL ENERGY STORAGE AND CONVERSION

Module 2 - 3 Credits (30 hours)

The course is divided in two modules:

MODULE 2 – Prof. Davide Pontara *(3 CFU - 30 hours)*
Batteries in Traction Applications

Office hours

from Monday to Friday, h 09:00-18:00 @ "LEMAD" Laboratory
upon mail request (davide.pontara@unibo.it)

Interdepartmental Centre for Industrial Research in Advanced Mechanical Engineering Applications and Materials Technology (CIRI-MAM)
Viale Risorgimento 2 – Bologna
tel: 051 209 3570 (office), 051 209 3586 (lab)
e-mail: davide.pontara@unibo.it
https://www.unibo.it/sitoweb/davide.pontara/en

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ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

SCHOOL OF ENGINEERING AND ARCHITECTURE

86461 - ELECTROMECHANCHEMICAL ENERGY STORAGE AND CONVERSION – Module 1

Monday 14:30 – 17:00 Room 4.1A – Gnd floor - Viale del Risorgimento 2 - Bologna
Wednesday 9:00 – 11:30 Room 5.4 A – 1st floor Viale del Risorgimento 2 – Bologna

Module 1 Timetable (Prof. Soavi)

18 September –28October 2019

Lab activities

1	2	3	4	5	6	7	8	9	10	11	12
18/9	23/9	25/9	30/9	2/10	7/10	9/10	14/10	16/10	21/10	23/10	28/10
September				October							

Student attendance signature is required for each lesson

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86461 - ELECTROMECHANCHEMICAL ENERGY STORAGE AND CONVERSION – Module 1

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Wednesday 9:00 – 11:30 Room 5.4 A – 1st floor Viale del Risorgimento 2 – Bologna

Module 2 Timetable (Prof. Pontara)

30 October – 9 December 2019

1	2	3	4	5	6	7	8	9	10	11	12
30/10	4/11	6/11	11/11	13/11	18/11	20/11	25/11	27/11	2/12	4/12	9/12
October- November									December		

Student attendance signature is required for each lesson

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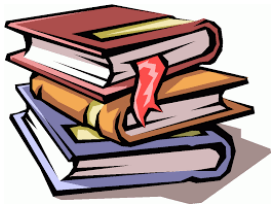
Readings/Bibliography



- Indications about reference texts (all available in the main libraries) will be done during the course. Papers and review articles will be also provided.

- Distribution of copies of extra-materials when needed and possibility to download the files of the lessons from websites of the professors and AMSCampus (http://campus.unibo.it)

Suggested Readings

Bruno Scrosati, K. M. Abraham, “Lithium Batteries: Advanced Technologies and Applications” Wiley, ISBN: 1118183657

Davide Andrea, “Battery Management Systems for Large Lithium Ion Battery Packs” 1st edition Artech House; ISBN: 1608071049

Thomas F. Fuller, John N. Harb ”Electrochemical Engineering” John Wiley & Sons, 2018, ISBN: 111900425X

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Assessment methods

The exam consists of two oral tests, one for each module.

The oral tests are are based on a program topic chosen by the student and two or more questions on the main program topics. The exam aims to determine both the acquisition of expected knowledge by the course program and the student's ability to find links among the covered topics, also using the reference material provided by the teacher

The final mark will be the average of the evaluation obtained by the student for the two modules.

Teaching tools

Power point presentations used during the lessons and any research material will be provided to the students in electronic format via Internet. The power point presentations used during the course will be uploaded on the university site before the corresponding lesson.
Students are invited to print the presentations and bring them to classes.
Training and laboratory activities related to the realization of numerical model of several ion lithium cells and experimental laboratory test for determining the cell parameters are planned

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Module 1 contents

- Basic aspects of energy storage and conversion systems such as batteries and and supercapacitors.
- Present state of the technology of rechargeable lithium batteries and supercapacitors for transport (electric and hybrid vehicles)
- Research and development of electrode and electrolyte materials for lithium batteries and supercapacitors.
- Exercise classes on the characterization of materials, electrodes and devices are planned.

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Module 1 contents

N.	Day	Content
1.	18th Sep.	Introduction. Basic concepts and quantities in chemsitry.
2.	23th Sep.	Basic concepts in electrochemistry
3.	25th Sep.	Electrochemical cells and energetics: thermodynamic and kynetics
4.	30th Oct.	Rechargeable Batteries
5.	2nd Oct.	Battery Performance: figure of merit
6.	7th Oct.	Excercise: how to evaluate cell perfomance?
7.	9th Oct.	Excercise
8.	10th Oct.	Lithium-ion batteries
9.	14th Oct.	Challenges in high perfomance Li-ion cell design
10	16th Oct.	Challenges in high perfomance Li-ion cell design
11	21st Oct.	Market trends
12	23rd Oct.	Beyond Lithium Batteries
13	28th Oct.	Supercapacitors

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Module 2 contents

- Vehicle classification (BEV, HEV, PHEV).
- Market of lithium batteries in the automotive field
- Discharge and Charge typical characteristics of batteries
- Lithium battery models
- BMS – Battery Management System(s)
- Charging of Evs
- Outline on CAN-bus
- Outline on LabVIEW
- Laboratory tests on cells and batteries

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