SSES
SUMMER SCHOOL ON ENERGY STORAGE

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE
UNIVERSITÀ DI PADOVA

PADOVA, 17 JULY – 04 AUGUST
FIFTH ANNOUNCEMENT

SSES

SUMMER SCHOOL ON ENERGY STORAGE

PADova, 17/07/23 – 04/08/23
A Higher Education Initiative

Supported by:
PNRR PE2 SPOKE 6 of the Italian Government

Organized by:
University of Padua & University of Tennessee Knoxville

Sponsored by:
Centro Studi di Economia e Tecnica dell’Energia Giorgio Levi Cases
Dipartimento di Ingegneria Industriale
Student profiles

- Master students
- PhD students
- Postdocs

Students from other Universities and Research Centers are welcome, e.g.:

- Italian University involved in PNRR PE2 SP6
- European University and Centers involved in the Flores Association
- Non-UNIPD and non-UTK students: a tuition fee of 150€ applies
Crediting for UNIPD Students

• Students of the LM in Electric Energy Engineering, Energy Engineering, Chemical and Process Engineering and Materials Engineering: 3 CFU in excess of their 120 CFU graduation program

• Students of the AMASE curriculum of the LM in Materials Engineering: 3 CFU within their 120 CFU graduation program

• PhD students will be credited 3 CFU
Syllabus

• Energy storage needs and technologies overview
• Electrochemistry fundamentals
• Electrochemical storage – chemistry - devices
  ❖ Advanced internal storage batteries: Li-based, Na-based, ...
  ❖ External storage batteries: flow batteries
  ❖ External storage systems: hydrogen + electrolyzer + fuel cell
• Electrochemical storage - engineering
  ❖ cell/stack losses and design
  ❖ battery management systems
  ❖ power conditioning systems
• Exercises at the end of each topic
• Experiments and modeling
• Development toward a project
• Final test
# Week 1

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<th>Monday</th>
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| **Section 1** | Fundamentals of electrochemistry 1  
Vito di Noto | Fundamentals of electrochemistry 2  
Vito di Noto | Fundamentals of electrochemistry 3  
Vito di Noto | Fundamentals of electrochemistry 4  
Vito di Noto | Fundamentals of electrochemistry 5  
Vito di Noto |
| **Section 2** | Energy Storage at Large 1  
Massimo Guarnieri | Energy Storage at Large 2  
Massimo Guarnieri | Device Structure  
Tom Zawodzinski | Device Processes 1  
Tom Zawodzinski | Device Processes 2  
Tom Zawodzinski |
## Week 2

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<td>Section 1</td>
<td>Engineering Aspects Tom Zawodzinski?</td>
<td>Batteries: Chemistry Tom Zawodzinski</td>
<td>Electrochemical Measurements Tom Zawodzinski</td>
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<td>Section 2</td>
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<td>Engineering Aspects Massimo Guarnieri</td>
<td>Electrochemical Measurements Tom Zawodzinski</td>
<td>Toward a 0D Model: Big Picture Tom Zawodzinski</td>
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## Week 3

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<td><strong>Fuel Cells</strong>&lt;br&gt;0-D Model 3&lt;br&gt;0D model of pol curve&lt;br&gt;Matthew Mench</td>
<td><strong>Flow Batteries</strong>&lt;br&gt;Doug Aaron&lt;br&gt;<strong>To be confirmed</strong></td>
<td><strong>Device Testing</strong>&lt;br&gt;Doug Aaron&lt;br&gt;<strong>To be confirmed</strong></td>
<td><strong>Project Presentations</strong>&lt;br&gt;All</td>
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<tr>
<td>Section 2</td>
<td><strong>Fuel Cells</strong>&lt;br&gt;0-D Model 2&lt;br&gt;pol curve analysis and losses&lt;br&gt;Matthew Mench</td>
<td><strong>Electrolyzers</strong>&lt;br&gt;Doug Aaron</td>
<td><strong>Device Testing</strong>&lt;br&gt;Massimo Guarnieri&lt;br&gt;<strong>To be confirmed</strong></td>
<td><strong>Systems</strong>&lt;br&gt;Massimo Guarnieri&lt;br&gt;<strong>To be confirmed</strong></td>
<td><strong>Project Presentations</strong>&lt;br&gt;All</td>
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Time plan

• Classes: 17/07–04/08 Monday to Friday 9:00 am – 01:00 pm

• Multi-modal classes:
  ❖ in presence, live online and streaming online (recorded) in room Be at the Department of Industrial Engineering – UNIPD - via Gradenigo 6/A - 35131 Padova - Italy
  ❖ hybrid attendance (in presence / online) is possible

• Teachers
  ❖ Thomas Zawodzinski – UTK-ORNL
  ❖ Matthew Mench – UTK
  ❖ Vito di Noto – UNIPD-BEPA
  ❖ Massimo Guarnieri – UNIPD-FBE
  ❖ Douglas Aaron – UTK

A one-day workshop focused on Long Duration Energy Storage will be held on 28 July with lectures by experts from research centers, associations and companies
Other activities

Visit the historic heritage of one of the oldest universities in the western world

- over 800 years in science and culture
- home of the scientific revolution
- Galileo Galilei desk
- the very first anatomic theater in the world

Venice, the amazing city on the water, at 30-min train distance

The Dolomites mountains at day-ride distance

And much more ...
Registration and info

1) Enrolling (all):
   SSES webpage
   https://stem.elearning.unipd.it/course/view.php?id=5799#section-3
   Password: SSES_2023!
   Students attending in presence/online are requested to inform. Please email:
   massimo.guarnieri@unipd.it to obtain login credentials

2) Additional enrolling for non-UNIPD and non-UTK students (150 € tuition fee applies):

We are sorry to be unable to offer economic support for travel and accommodation

More info: massimo.guarnieri@unipd.it