UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

"Modeling and Control of Electrochemical Energy Storage Systems"

Prof. Federico Baronti and Dr. Roberto Di Rienzo

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Short Abstract: Electrochemical Energy Storage Systems (EESSs) are vital components in various applications, including electric mobility, portable devices and tools, as well as stationary applications. Optimal control of EESSs requires a sophisticated electronic system, typically called a Battery Management System, which monitors the EESSs, estimates its internal state variables, and identifies the best control actions.

This course aims to provide PhD students with the knowledge and skills to make informed use of EESSs in their research field. It is divided into three modules: an introduction to different types of EESSs and their applications, a description of commonly used models [1], and a focus on Battery Management Systems and their main functions [2, 3].

Course Contents in brief:

- Introduction of Energy storage systems
  - Electrochemical energy storage systems
  - Electric vehicle applications
  - Stationary applications for smart-grids
- Modelling of Lithium-ion battery
  - Introduction of electrochemical models
  - Equivalent circuit models
- Battery management system
  - Introduction of commercial battery stack monitors
  - State estimation algorithms
  - Charge equalization

Total # of hours of lecture: 12

References:

[1] Nicodemo N., Di Rienzo R., Lagnoni M., Bertei A., Baronti F.; Estimation of lithium-ion battery electrochemical properties from equivalent circuit model parameters using machine learning; Journal of Energy Storage, 99, 113257, 2024

[2] Di Rienzo R., Nicodemo N., Verani A., Baronti F., Roncella R., Saletti R.; A novel methodology to study and compare active energy-balance architectures with dynamic equalization for second-life battery applications; Journal of Energy Storage, 73, art. no. 108772, 2023

[3] Morello R., Di Rienzo R., Roncella R., Saletti R., Baronti F. Hardware-in-the-loop platform for assessing battery state estimators in electric vehicles; IEEE Access, 6, art. no. 8528300, pp. 68210 – 68220, 2018

CV of the Teacher

Federico Baronti (Senior Member, IEEE) was born in Pisa, Italy, in 1975. He received the M.Sc. and Ph.D. degrees in electronic engineering from the University of Pisa, Italy, in 2001 and 2005, respectively. He is currently an Associate Professor at the Department of Information Engineering, University of Pisa. He has worked on the design of innovative electronic systems aimed at improving the performance, safety, and comfort of road vehicles. His most recent activities concern Li-ion battery modeling and the development of advanced battery management systems. He is or has been the Principal Investigator for the University of Pisa in 4 projects funded by the European Commission on the topic of electric mobility and autonomous driving. He has co-authored around 140 publications in international journals and conference proceedings. He received the Best Paper Award of IEEE Industrial Electronics Magazine, in 2013. He has served as Chair of the IEEE-IES Technical Committee on Energy Storage and is currently the Chair of the IEEE-IES Technical Committee on Resilience and Security for Industrial Applications. He is an Associate Editor of the IEEE Transactions on Industrial Informatics and the Open Journal of Industrial Electronics Society.

Roberto Di Rienzo was born in Avellino, Italy, in 1989. He received the M.Sc. degree in electronic engineering from the University of Pisa in 2014 and the Ph.D. degree in information engineering from the University of Pisa, Italy, in 2018. He is currently a Research Fellow with the Department of Information Engineering, University of Pisa. His research focuses on the Li-ion battery modeling and the design of electronic systems for the management of batteries for high- and medium-power applications.

Final Exam: Written test

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule:

Tuesday, January 14, 2025, h. 9:00-13:00

Wednesday, January 15, 2025, h. 9:00-13:00

Thursday, January 16, 2025, h. 9:00-13:00