Prof. Dr. Ismael SAADOUNE

Professor at University Cadi Ayyad focussing on Material Science with the specific research topic 'Active Materials for Lithium and Sodium-ion Batteries' . Founder of Materials and Environmental Chemistry Laboratory (100 graduate, 40 Master students and 25 PhD Students are supervised to date). All R&D topics are related to the Industry. Mr Saadoune is PI of 17 research funded projects on Battery Materials. He was involved in two European Master ERASMUS MUNDUS: 'Materials for Energy Storage and Conversion' and 'Functionalized Advanced Materials and Engineering' . He received several awards (from Tokyo University of Science, Japan, IRESEN). He is invited to deliver lectures at Uppsala University, Sweden; Argonne National Lab., USA

Syllabus	**Energy Storage & Battery Materials**
Courses description ***Weekly Schedule of Course Topics covered and Out of Class Assignments***	*The use of eco-friendly electrical mobility and renewable energy sources requires the development of adequate and efficient energy storage technologies. Depending on the storage applications (stationary or mobile), numerous storage routes exist including Pumped Hydro Energy Storage, Compressed Air Energy Storage, Electrochemical Energy Storage….* *Energy storage simply consists of saving a quantity of energy for later use. It mainly concerns the storage of electricity and heat.. It makes it possible to adjust the "production" and "consumption" of energy while limiting losses. Energy, stored when its availability exceeds requirements, can be provided when demand is greater. Faced with the intermittent or fluctuating production of certain energies, for example renewable energies, this operation also makes it possible to meet constant demand.* *Storage methods depend on the type of energy. Fossil energy sources (coal, gas, petroleum), in the form of reservoirs in their natural state, naturally fulfill the function of stocks. Once extracted, they can easily be isolated, housed and technically transported. Storage is more complex for intermittent energies: their production is relayed by energy vectors such as electricity, heat or hydrogen, requiring specific storage systems* *Several storage technologies will be discussed in this course :* *•Pumped Hydro Energy Storage (PHES)* *•Compressed Air Energy Sotrage (CAES)* *•Thermal Energy Sotrage (TES)* *•Chemical Energy Storage (CES)* *•Electrochemical Energy Storage (EES)* *More attention will be focused on the last technology (EES) by presenting many Battery Materials including those active in Lithium ion batteires, Sodium ion Batteries, Redox Flow, Fuel Cell … In fine, the aim is that students can distinguish different storage solutions and could be able to choose the appropriate solution for a given storage problem.*
Pre-requisites	*Renewable energies : Fundamentals; Crystal Structure; Electrochemistry – General Chemistry Thermodynamics*
Textbook(s) and other reading materials	*• Energy Storage: Fundamentals, Materials and Applications, Huggins Robert (2016) DOI 10.1007/978-3-319-21239-5* *• Energy Storage Systems, David Elliott (2018), DOI https://doi.org/10.1088/978-0-7503-1531-9* *• Advanced Battery Materials, Chunwen Sun (2019), DOI:10.1002/9781119407713* *• Reviews & Publications (Scopus & Web Of Science)* *• Available reading materials on the internet*
Delivery & Duration	*Online Classes / #meeting per week, # hour meeting (TO be fixed)*
Who this programme is for	*Graduate students (Bachelor, Master, Ing. , PhD)*
Certificate of Completion	*Upon completion of a course, and once the participation has been verified, the candidate will receive an electronic certificate to download, print, and keep in his records* *Signed by the VLU/Dr. Prof. Ismael Saadoune*
Media Tools	*Virtual courses / Zoom management by Sabaek for Education & Training (Bahrain)*
Contents & Chapters	*1. Introduction Energy Storage Systems and Fundamental* *2. Energy Storage Classification* *3. Physical Energy Storage 3.1. Pumped Hydro Enery Storage* *3.2. Compressed Air Energy Storage* *3.3. Thermal Energy Storage* *3.4. Flyweels* *4. Chemical Energy Storage* *5. Electrochemical Energy Storage 5.1. Redox & Definition of energetic Charactertics* *5.2. Electrochemical Characterizations (Galvanostatic, GITT, CV, EIS..)* *5.3. Battery History* *5.4. Lead Acid Battery* *5.5. Ni-Cd and Li-Metal Hydrid Batteries* *5.6. From Li- to Li-ion Batteries* *5.7. Li-ion Batteries components :* *• Cathode materials (Oxides, Phosphates, others..)* *• Anode Materials (Carbon, Silicon, Other..)* *• Electrolyte (Formulations.)* *• Battery Assembling and Tests* *• Li-ion Batteries Market & Forecast* *• Limitations of Li-ion batteries technology 5.8. Beyong Lithium-ion Batteries* *• Sodium ion Batteries (anode, cathode, Electrolyte)* *• Lithium-air Batteries* *• Lithium-sulfur Batteries* *• Redox-Flow Batteries* *• Capacitors* *• 'Multivalent' batteries*
Application Deadline	*Send an e-mail to to receive zoom invitation*