23MS801 Sustainable Hydrogen and Electrical Energy Storage 4 0 0 4

Pre-requisite: Engineering Materials and Material Thermodynamics.

Course Description and Objectives:

To provide concepts on the principles of hydrogen energy technology and electrical energy storage and compare different methods to store hydrogen and electrical energy.

Course Outcomes:

CO Code	Course Outcome statement
01	Assess the suitability of different energy storage systems for different end use applications based on thermodynamic principles and performance-related factors.
02	Apply basic electrochemistry concepts including Nernst law and the Tafel equation to describe the redox reactions and charge transfer at the electrode/electrolyte interface in different battery chemistries.
03	Identify the process variables for different hydrogen production methods.

Pedagogy: Conceptualising, applying & analysing

Syllabus:

Introduction to energy storage; Basic Electrochemistry; Thermodynamics of Battery: Applications Nernst law to describe redox reaction in different battery systems; Application of Tafel equation to describe the charge transfer between electrode and electrolyte; calculation of capacities, energy and power densities for different battery materials and battery chemistries, Gibbs free energy, chemical potential, Nernst equation; Solid state reaction mechanisms; phase diagrams; phase rule; interpretation of the phase diagram with respect to (de)lithiation, voltage profiles; Lithium Ion Batteries; Electrolyte stability: Pourbaix diagram, band structures solids, cycle life; Kinetics in batteries charge transport: Butler-Volmer, diffusion, solid state diffusion; Supercapacitors; comparison batteries/systems.

Hydrogen production using: Fossil fuels, Biomass, Water Electrolysis, Photo-Electrolysis of water, Thermonuclear, Photocatalysis; Hydrogen transport and compression; Requirements of Hydrogen storage; liquid hydrogen storage and surface adsorption of H_2; Hydrogen storage: Clathrates, chemical bonded H_2, conventional and light metal hydrides, composites.

References:

1. David Linden and Thomas Reddy, "Handbook of batteries", McGraw-Hill Education; 3rd edition.
2. Robert A. Huggins" Advanced Batteries, Materials Science Aspects: Springer-Verlag US 2009.

3. Prof. Dr. Andreas Züttel, Dr. Andreas Borgschulte, Prof. Dr. Louis Schlapbach" Hydrogen as a Future Energy Carrier" Wiley, 20 February 2008

Evaluation Criteria

1. Midterm -30%
2. Continuous Assessment: 30%
3. End semester exam: 40%

Employability: Renewable energy sectors, Electric mobility and petroleum industries.