Approved in 44th BoA Meeting (24-11-2021)

Course number : EN 503
Course Name : Energy Storage Technologies
Credit Distribution : 3-0-0-3
Intended for : UG/PG (Elective)
Prerequisite : None
Mutual Exclusion : None

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1. Preamble:

The emerging energy generation sources such as solar and wind generates energy in variable patterns. Hence, energy storage is becoming of major importance to store and supply energy without any interruption. The energy storage can be in mechanical, electrochemical, or chemical forms.

2. Course Modules with quantitative lecture hours:

Module 1: Energy storage systems overview - Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market. (5 Hours)

Module 2: Thermal storage system-heat pumps, hot water storage tank, solar thermal collector, application of phase change materials for heat storage-organic and inorganic materials, efficiencies, and economic evaluation of thermal energy storage systems. (6 Hours)

Module 3: Chemical storage system- hydrogen, methane etc., concept of chemical storage of solar energy, application of chemical energy storage system, advantages and limitations of chemical energy storage, challenges, and future prospects of chemical storage systems. (5 Hours)

Module 4: Electromagnetic storage systems - double layer capacitors with electrostatically charge storage, superconducting magnetic energy storage (SMES), concepts, advantages and limitations of electromagnetic energy storage systems, and future prospects of electrochemical storage systems. (5 Hours)

Module 5: Electrochemical storage system (11 Hours)

(a) Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery& Metal hydride battery vs lead-acid battery.

(b) Supercapacitors- Working principle of supercapacitor, types of supercapacitors, cycling and performance characteristics, difference between battery and supercapacitors, Introduction to Hybrid electrochemical supercapacitors

(c) Fuel cell: Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-supercapacitor systems.

Module 6- Battery design for transportation, Mechanical Design and Packaging of Battery Packs for Electric Vehicles, Advanced Battery-Assisted Quick Charger for Electric Vehicles, Charging Optimization Methods for Lithium-Ion Batteries, Thermal run-away for battery systems, Thermal management of battery systems, State of Charge and State of Health Estimation Over the Battery Lifespan, Recycling of Batteries from Electric Vehicles. (10 Hours)

3. Text books:

- Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011)
- Ralph Zito, Energy storage: A new approach, Wiley (2010)

4. Reference:

- Pistoia, Gianfranco, and Boryann Liaw. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer International Publishing AG, 2018.
- Robert A. Huggins, Energy storage, Springer Science & Business Media (2010)

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1				

5. Justification of new course proposal if cumulative similarity content is >30%:
None. It is a revision of previous version of EN503