ENERGY STORAGE TECHNOLOGIES

Course Code	23ME4602A	Year	III	Semester	II
Course Category	Professional Elective-III	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	MP
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Objectives: To

- Get the insights into importance of energy storage systems
- Understand the chemical and electromagnetic storage systems
- Know the principles of electrochemical storage systems
- Learn the working of supercapacitors and fuel cells
- Know how to design batteries for transportation

Course Outcomes: At the end of the course, students will be able to

- Learn the importance of energy storage systems
- Gain knowledge on chemical and electromagnetic storage systems
- Understand the principles of electrochemical storage systems
- Know the working of supercapacitors and fuel cells
- Learn how to design batteries for transportation

UNIT 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. 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.

UNIT 2:

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.

Electromagnetic storage systems - double layer capacitors with electrostatically charge storage,superconducting magnetic energy storage (SMES), concepts, advantages and limitations ofelectromagnetic energy storage systems, and future prospects of electrochemical storage systems.

UNIT 3:

Electrochemical storage system

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

UNIT 4:

Super capacitors- Working principle of super capacitor, types of super capacitors, cycling and performance characteristics, difference between battery and super capacitors, Introduction to Hybrid electrochemical super capacitors

Fuel cell- Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-super capacitor systems.

UNIT 5:

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.

Text books:

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

References:

1. Pistoia, Gianfranco, and BoryannLiaw. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer International Publishing AG, 2018.

2.Robert A. Huggins, Energy storage, Springer Science & Business Media (2010**)**