Course title : Electric Vehicle, Energy Storage System and Hydrogen Technologies
Course credits : 2
No. of modules : 2
Module 1: Electric Vehicle & Energy Storage System
Module 2: Hydrogen Energy Technologies

Detailed syllabus:

Module 1: Electric Vehicle & Energy Storage System

I. Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) Developments:
Historical developments, recent developments, National Electric Mobility Mission Plan (NEMMP).
Policies and regulations for EV adoption, Faster Adoption and Manufacturing of(Hybrid &) Electric Vehicles in India (FAME India) Scheme.
State of art EVs and HEVs, EV configurations, EV parameters, HEV configurations,Power flow control.

II. Electric Propulsion:
Different types of power converter based DC motor drives, induction motor drives, permanent magnet motor drives, Switched reluctance motor drives.

III. Energy Sources:
Basics- Parameters-Capacity, Discharge rate, State of charge, state of Discharge ofBatteries, Fuel cells, Ultra-capacitors, Flywheels.

IV. EV auxiliaries:
EV charging standards like CCS, ChaDeMo (Japanese), GB/T (Chinese), Bharat AC-001 and DC-001 and other BIS standards; Battery characteristics and chargers, Battery indication and management, Temperature control units, Power steering units, Auxiliary power supplies, Navigation systems, Regenerative Braking systems. Safety aspects.

V. Necessity and types of energy storage system:
Necessity of energy storage, policy and regulatory developments in energy storage, recent standards for energy storage systems - MESA, IEC, IEEE.
Different types of energy storage – mechanical, chemical, electrical, electrochemical, biological, magnetic, electromagnetic, and thermal. Comparison of energy storage technologies.

VI. Energy Storage Systems
Thermal energy storage, sensible and latent heat, phase change materials, Energy and exergy analysis of thermal energy storage, electrical energy storage-super- capacitors, magnetic energy storage-superconducting systems, Mechanical-Pumped hydro, flywheels and pressurized air energy storage, Chemical-Hydrogen production and storage, Principle of direct energy conversion using fuel cells, thermodynamics of fuel cells, Types of fuel cells, AFC, PEMFC, MCFC, SOFC, Microbial fuel cell, Fuel cell performance, Electrochemical Energy Storage- Cell design - principles of "anode, cathode and electrolyte", Construction and operation of Battery Storage Systems-primary, secondary and flow batteries.

Module 2: Hydrogen Energy Technologies

I. Hydrogen energy systems:
Policies and regulations for promotion of hydrogen, National Green HydrogenMission.
Concept of grey, blue and green hydrogen; Properties of hydrogen as fuel, Hydrogen pathways, Introduction-current uses, general introduction to infrastructure requirement for hydrogen production, storage, dispensing andutilization, and hydrogen production plants.

II. Hydrogen production processes:
Thermal-Steam reformation, thermo-chemical water splitting, gasification- pyrolysis, nuclear thermal catalytic and partial oxidation methods.
Electrochemical- Electrolysis, photo electro chemical method.

III. Hydrogen storage and safety:
Physical and chemical properties, general storage methods, compressed storage- composite cylinders, metal hydride storage, carbon based materials for hydrogenstorage. Hydrogen safety aspects, backfire, pre-ignition, hydrogen emission
NOx control techniques and strategies, Hydrogen powered vehicles.

Evaluation/Assessment scheme:

1. Quizzes – 40% (one at the end of each module)
2. End semester exam – 60% (at the end of course)

Learning outcomes:

At the end of the course the student will be able to:

- Learn fundamentals of advanced batteries, super-capacitors and fuel cells for electrification of vehicles.
- Learn hybridization of various energy conversion devices for vehicle electrification.
- Understand battery management systems and state-of-charge estimation.
- Understand the overall operation of Electric vehicles.
- The student will be able to cope up with upcoming technologies in the energy storage systems.
- Minimize environmental hazards associated with the use of hydrogen storage and fuel cell technology