NIRMA UNIVERSITY

Institute:	**Institute of Technology, School of Engineering**
Name of Programme:	**B. Tech.**
Semester:	**VII**
Course Code:	4EE306IE25
Course Title:	**Battery Management and Charging System**
Course Type:	**Interdisciplinary Minor - (Elective Course-II)**
Year of Introduction:	**2025 – 26**

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Course Learning Outcomes (CLOs):

At the end of the course, the students will be able to –

1. interpret the concept of battery management system (BL2)
2. estimate the health of battery (BL5)
3. design battery charging system (BL6)
4. define specifications to develop charger for EV applications (BL4)

Unit	Contents	Teaching hours (Total 45)
Unit-I	**Battery Management System** Introduction and BMS functionality, battery pack topology, voltage sensing, temperature sensing, current sensing, high-voltage contactor control, isolation sensing, synchronization of current and voltage, protection, communication interface, range estimation, cell total energy and cell total power, thermal management, operational modes, cell balancing, causes of imbalance, circuits for cell balancing: active cell balancing, passive cell balancing, charge transfer balancing: flying capacitor flying capacitor, inductive charge transfer balancing, transformer charge balancing, dissipative balancing	13
Unit-II	**Battery State of Charge and State of Health Estimation** Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, battery health estimation, Lithium-ion aging: negative electrode, Lithium-ion aging: positive electrode	08
Unit-III	**Battery Charging Systems** Charging strategies, types of charging systems, CC and CV charging methods, target voltage method, pulse charging technique, converter topologies for chargers, unidirectional and bidirectional battery chargers, isolated bidirectional DC-DC converter, mechanism of wireless charging, V2G and G2V interface, battery charging standards, charging protocols and policies	12

Unit-IV	**AC & DC Chargers** levels of charger, AC pile charger, DC pile charger, challenges of DC fast charger, types of connectors, EVSE power module selection and technical specification, selection of EVSE communication protocol (PLC / ethernet / Modbus/ CAN module), communication gateway, specification of open charge point protocol (OCCP 1.6/2.0), Bharat DC001 & AC001 charger specification, communication interface between charger and CMS (central management system), payment apps	12

Self-Study:
The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Laboratory Work:
This shall consist of at least 10 laboratory experiments / simulations based on the syllabus.

Suggested Readings:

1. Gregory L. Plett, *Battery Management Systems, Vol. I: Battery Modelling*, Artech House.
2. Sandeep Dharmeja, *Electric Vehicle Battery Systems*, Newnes.
3. James Larminie, John Lowry, *Electric Vehicle Technology Explained*, John Wiley & Sons.
4. Chung Chow Chan, K. T. Chau, *Modern Electric Vehicle Technology*, Oxford University Press.
5. Michael H Westbrrok, *The Electric Car - Development and Future of Battery, Hybrid and Fuel Cell Cars*, IEE Power and Energy Series 38, The Institution of Electrical Engineers.
6. *Handbook of Electric Vehicle Charging Infrastructure Implementation*, NITI Aayog
7. International standards in use, relevant research papers and articles.
8. Research Papers on IEEE/IET/Science Direct etc.

Suggested List of Experiments :

Sr. No.	Name of Experiments/Exercises	Hours
1.	To model a Li-ion battery cell using MATLAB.	02
2.	Demonstration of battery characterization for charging and discharging conditions.	02
3.	Simulation and analysis of constant current-constant voltage charging technique.	02
4.	Simulation and analysis of trickle charging technique.	02
5.	Simulation and analysis of passive and active cell balancing.	04
6.	Demonstration of battery management system.	02
7.	Simulation and analysis of on-board charger.	02
8.	Simulation and analysis of bidirectional power flow control in vehicle.	02
9.	Simulation and analysis of vehicle to grid and grid to vehicle interfacing.	04
10.	Simulation of fast dc charging system.	02