BATTERY MANAGEMENT SYSTEMS AND CHARGING STATIONS

Course Code	23EE2701A	Year	IV	Semester	I
Course Category	Open Elective - III	Branch		Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Electric Circuits and Power Electronics
Continuous Internal Evaluation:	30	Semester End Evaluation:	70	Total Marks:	100

Course Outcomes	
Upon successful completion of the course, the student will be able to	
CO1	Understand the fundamentals of battery systems, including cell characteristics, battery parameters, charging/discharging processes, and safety considerations.(L2)
CO2	Explain the architecture and working of Battery Management Systems (BMS), including sensing techniques, protection mechanisms, and communication interfaces.(L3)
CO3	Analyze battery performance through estimation of State of Charge (SOC) and State of Health (SOH), and evaluate methods for cell balancing.(L4)
CO4	Apply modeling and simulation techniques such as equivalent circuit models and physics-based models to analyze battery and electric vehicle performance.(L3)
CO5	Evaluate different charging infrastructures and technologies used in electric vehicles, including fast charging and battery swapping systems.(L4)

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2									2	3	
CO2	3	3	2		1						2	3	
CO3	3	3	2		1						2	3	
CO4	3	2	3		3						2	3	
CO5	2	2	2		2	2	2	1			2	3	

SYLLABUS		
Unit No.	**Contents**	**Mapped CO**
I	**Introduction** Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells,	**CO1 CO2**

	Rechargeable cells, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.	
II	**Battery Management System** Requirement Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation, Cell total energy and cell total power.	**CO1** **CO2**
III	**Battery State of Charge and State of Health Estimation, Cell Balancing** 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, Cell Balancing, Causes of imbalance, Circuits for balancing.	**CO1** **CO3**
IV	**Modelling and Simulation** Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, simulating an electric vehicle, Vehicle range calculations, simulating constant power and voltage, Simulating battery packs. Battery-Management-System Requirements.	**CO1** **CO4**
V	**Charging Infrastructure** Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and charge zone.	**CO1** **CO5**

Learning Resources
Text Books:
1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015. 2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
Reference Books:
3. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems Design by Modelling" Philips Research Book Series 2002. 4. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010 5. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.
E-Resources:
1. https://nptel.ac.in/courses/108106170 2. http://www.digimat.in/nptel/courses/video/108106170/L65.html