22EEHO308	BATTERY MANAGEMENT SYSTEMS		SEMESTER			
PREREQUISTIES		**CATEGORY**	**PEC**	**Credit**		**3**
Basics of Electrical Engineering, Electric Circuit theory, Chemistry and Physics		**Hours/Week**	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

Course Objectives:

To understand different techniques of digital relaying - their constructions, working principles, applications and limitations along with introduction to Wide Area Measurement System and network protection.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Introduction to Battery Management System(BMS), Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging

UNIT II	**BATTERY-MANAGEMENT-SYSTEM REQUIREMENTS.**	**9**	**0**	**0**	**9**

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.

UNIT III	**BATTERY STATE OF CHARGE AND STATE OF HEALTH ESTIMATION**	**9**	**0**	**0**	**9**

Preliminary definitions. - Battery state of charge estimation (SOC)- voltage-based methods to estimate SOC , Model-based state estimation - Battery State of Health Estimation (SOH) - Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode

UNIT IV	**MODELLING AND SIMULATION.**	**9**	**0**	**0**	**9**

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.

UNIT V	**DESIGN OF BMS**	**9**	**0**	**0**	**9**

Design of battery BMS: Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system

Total (45L) = 45 Periods

Text Books:

1.	Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2.	Plett, G., Battery Management Systems: Volume II, Equivalent-Circuit Methods, Artech House, 2015
3	Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.

Reference Books:

1.	Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010
2.	Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

Course Outcomes: Upon completion of this course, the students will be able to:			**Bloom's Taxonomy Mapped**
CO1	:	Recall the role of battery management system	L1: Remembering
CO2	:	Identify the requirements of Battery Management System w.r.t application	L2: Understanding
CO3	:	Analyze the concept associated with battery charging / discharging process	L4: Analysing
CO4	:	Assess the various parameters of battery and battery pack	L3: Applying
CO5	:	Design the battery pack model.	L4: Analysing

COURSE ARTICULATION MATRIX

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	2	2	2	2	2	2	1					1	2	2	1
CO2	1	2	2	2	2	2	1					1	2	2	1
CO3	2	3	3	3	3	2	1					1	3	2	1
CO4	3	3	3	3	3	2	1					1	3	2	1
CO5	2	2	3	3	3	3	1					1	3	2	1
Avg	2	2.4	2.6	2.6	2.6	2.2	1	0	0	0	0	1	2.4	1.9	1

3/2/1-indicates strength of correlation (3- High, 2-Medium, 1- Low)