Course Name: EV Battery Management System

ABOUT THE COURSE

TOTAL DURATION:	45HRS
MODE OF DELIVERY	PHYSICAL CLASSROOM TRAINING AT RESPECTIVE COLLEGES
TRAINER TO STUDENT RATIO:	1:50
TOTAL MARKS:	75

TABLE 1	
OVERALL COURSE OBJECTIVE:	• Summaries the principles of electric vehicle (EV) battery technology and its significance in sustainable transportation. • Gain proficiency in managing and maintaining EV batteries, including charging, monitoring, and diagnostics. • Recognize the strategies for optimizing EV battery performance, extending lifespan, and ensuring environmental sustainability. • Develop skills in analysing battery data and implementing efficient battery management practices. • Explore emerging trends and innovations in EV battery technology for future applications.
LEARNING OUTCOME:	• Demonstrate a comprehensive understanding of EV battery technology and its management. • Implement efficient charging strategies and maintenance practices for EV batteries. • Analyse battery data and apply diagnostic techniques for monitoring battery health. • Optimize EV battery performance and lifespan through effective management techniques. • Identify and discuss emerging trends and sustainable practices in EV battery technology.

TABLE 2: MODULE WISE COURSE CONTENT AND OUTCOME				
SL.NO	**MODULE NAME**	**MODULE CONTENT**	**MODULE LEARNING OUTCOME**	**DURATION (HRS)**
1	Fundamentals of Battery Management Systems	Introduction to Electric vehicle – Architecture of EV - Introduction to BMS-Definition and Purpose -	Demonstrate a comprehensive understanding of EV battery technology and its management.	8

		Evolution and Importance in Modern Systems-BMS Design and Architecture-Components and Functional Blocks-System Integration and Interfaces-Connecting Battery with BMS-Communication Protocols (CAN, SPI, etc.)-Wiring and Interface Considerations		
2	Safety Measures and Protections in BMS	Safety in BMS-Importance and Regulatory Compliance-Hazard Analysis and Risk Mitigation--Protection Mechanisms-Overvoltage Protection-Reverse Polarity Protection Overcurrent Protection Thermal Management-Temperature Sensing and Control-Cooling Systems and Heat Dissipation	Implement efficient charging strategies and maintenance practices for EV batteries.	8
3	Battery Health Monitoring and Estimation	Battery monitoring systems and sensors-Diagnostic tools for assessing battery health interpretation and analysis for battery diagnostics-Predictive maintenance	Analyse battery data and apply diagnostic techniques for monitoring battery health.	10

		strategies for EV batteries- Strategies for Cell Health Preservation-Fault Detection and Isolation-State of Charge (SOC) Estimation- Methods and Algorithms- Challenges and Accuracy Improvement- State of Health (SOH) Prediction and Estimation- Predictive Models and Analysis- Long-term Health Assessment Techniques		
4	Optimizing EV Battery Performance	Strategies for enhancing battery lifespan- Temperature management and thermal considerations- Balancing techniques for battery cells- Role of software in optimizing EV battery performance	Optimize EV battery performance and lifespan through effective management techniques.	8
5	Integration of IoT for Battery Status	IoT Implementation in Battery Systems- Remote Monitoring and Data Acquisition- Connectivity and Network Considerations- Utilizing ARM Microcontrollers for Battery Management and Monitoring Capabilities- Integration	Identify and discuss emerging trends and sustainable practices in EV battery technology.	10

		Challenges and Solutions- Advancements in Battery Management Systems- Emerging Trends and Future Prospects-Case Studies and Industry Applications		

TABLE 3: OVERALL COURSE LEARNING OUTCOME ASSESSMENT CRITERIA AND USECASES		
LEARNING OUTCOME	**ASSESSMENT CRITERIA**	**USECASES**
Demonstrate a comprehensive understanding of EV battery technology and its management.	• Interpret the architecture of an Electric Vehicle • Analyse integration and interface • Identify components and functional blocks • Select correct communication protocols	**Design A battery management system Circuit for A Single Li-Ion Battery Cell with overvoltage and Reverse polarity protection.** Task 1: Simulate The basic Electrical and Electronics Components in Autodesk Tinkercad Software (BJT And MOSFET Switching) Task 2: Simulate A Function Generator and CRO Using Autodesk Tinker cad Task 3: Simulate A Voltage Divider and Voltage Reference Using Autodesk Tinker cad Task 4: Hands-on with the Different Components Used in BMS And Simulate It Using Autodesk Tinker cad Task 5: Design A BMS Circuit for a Single Li-ion Battery
Implement efficient charging strategies and maintenance practices for EV	• Interpret regulatory compliances • Evaluate various protection systems	**Design A battery management system Circuit for 4S1P with overvoltage and**

batteries	• Evaluate protection mechanisms	**overcurrent protection.** Task 1: Simulate The basic Electrical and Electronics Components in Autodesk Tinkercad Software (BJT And MOSFET Switching) Task 2: Simulate A Function Generator and CRO Using Autodesk Tinker cad Task 3: Simulate A Voltage Divider and Voltage Reference Using Autodesk Tinker cad Task 4: Hands-On the Building A Battery Pack and Simulate It Using Autodesk Tinker cad Task 5: Design A battery management system Circuit for 4S1P with overvoltage and overcurrent protection
Analyse battery data and apply diagnostic techniques for monitoring battery health.	• Use diagnostic tools for assessing battery health • Develop maintenance predictive strategies • Perform health analysis of a battery	**Design A Real-Time SOC Estimation Circuit for A Battery** Task 1: Simulate The basic Electrical and Electronics Components in Autodesk Tinkercad Software (BJT And MOSFET Switching) Task 2: Simulate A Function Generator and CRO Using Autodesk Tinker cad Task 3: Simulate A Battery and Measure Using a mega Microcontroller using Autodesk Tinker cad Task 4: Hands-On Programming in ATMEGA Microcontroller and Simulate it Using Autodesk Tinker cad Task 5: Design A Microcontroller Based SOC Estimation Circuit

Optimize EV battery performance and lifespan through effective management techniques.	• Evaluate various strategies to assess battery life • Use software in optimizing EV battery performance	**Design A Real-Time Prediction Circuit for Battery Operation** Task 1: Simulate The basic Electrical and Electronics Components in Autodesk Tinkercad Software (BJT And MOSFET Switching) Task 2: Simulate A Function Generator and CRO Using Autodesk Tinker cad Task 3: Simulate A Battery Pack and Measure Using ATMEGA Microcontroller using Autodesk Tinker cad Task 4: Hands-On Programming in ATMEGA Microcontroller and Simulate it Using Autodesk Tinker cad **Design A Real-Time Battery Testing and Monitoring System (Single Cell).** Task 1: Simulate The basic Electrical and Electronics Components in Autodesk Tinker cad Software (BJT And MOSFET Switching) Task 2: Simulate A Function Generator and CRO Using Autodesk Tinker cad Task 3: Simulate A Battery and Voltage Reference Using Autodesk Tinker cad Task 4: Hands-On Programming in ATMEGA Microcontroller and Simulate it Using Autodesk Tinker cad Task 5: Design An ATMEGA Microcontroller Battery Testing Circuit

Identify and discuss emerging trends and sustainable practices in EV battery technology.	• Identify techniques to integrate IoT techniques • Utilizing ARM Microcontrollers for Battery Management • Provide solutions for IoT integration	**Design A Real-Time Battery Testing and Monitoring System (Battery Pack)** Task 1: Simulate The basic Electrical and Electronics Components in Autodesk Tinkercad Software (BJT And MOSFET Switching) Task 2: Simulate A Function Generator and CRO Using Autodesk Tinker cad Task 3: Simulate A Battery and Voltage Reference Using Autodesk Tinker cad Task 4: Hands-On Programming in ATMEGA Microcontroller and Simulate it Using Autodesk Tinker cad Task 5: Design An ATMEGA Microcontroller Battery Testing Circuit

TABLE 4: LIST OF FINAL PROJECTS (20 PROJECTS THAT COMPREHENSIVELY COVER ALL THE LEARNING OUTCOME)	
SL.NO	**FINAL PROJECT**
1	Design A battery management system Circuit for A Single Li-Ion Battery Cell with overvoltage and Reverse polarity protection.
2	Design A battery management system Circuit for 4S1P with overvoltage and overcurrent protection.
3	Design A Real-Time SOC Estimation Circuit for A Battery
4	Design A Real-Time Prediction Circuit for Battery Operation
5	Design A Real-Time Battery Testing and Monitoring System (Single Cell).
6	Design A Real-Time Battery Testing and Monitoring System (Battery Pack)
7	Monitor the State of Health of Lithium-Ion Battery
8	Design and develop a model for Battery cell balancing using single inductor
9	Design and develop a model for Battery cell balancing using single inductor
10.	Develop a real-time SOC estimation circuit for efficient monitoring of EV batteries.
11.	Design an Inductor Based Active Cell Balancing for Electric Vehicle

12.	Implement real-time SOC estimation for EV batteries to optimize range and performance
13.	Design Capacitor Based Active Cell Balancing of Four (4) Lithium-Ion Cells
14.	Create a testing and monitoring system for single-cell batteries used in industrial automation equipment
15.	Design a Thermal protection circuit for EV battery – integrated into BMS
16.	Develop BMS with low power consumption
17.	Monitor battery packs in electric cars for range and performance.
18.	Design a protection circuit for electric vehicle Battery
19.	Design of Bidirectional DC/DC Battery Management System for Electrical Vehicle
20.	Design a Battery Management system using CAN communication

TABLE 5: COURSE ASSESSMENT RUBRICS (TOTAL MARKS: 75)				
ASSESSMENT CRITERIA	**DESCRIBE THE CRITERIA OF THE BELOW CATEGORY PERFORMANCE**			**TOTAL MARKS**
	FAIR	**GOOD**	**EXCELLENT**	
Demonstrate a comprehensive understanding of EV battery technology and its management.	Demonstrates a basic familiarity with architecture, components and functional blocks	Analyse integration and interfaces of an EV	Connecting battery with BMS communication protocols	15
Implement efficient charging strategies and maintenance practices for EV batteries	Familiarity with diagnostic tools for assessing battery health	Implement Predictive maintenance strategies for EV batteries	Gain expertise in Fault Detection and Isolation techniques Perform State of Charge (SOC) Estimation Analyse Predictive Models and Analysis-Long-term Health Assessment Techniques	20
Optimize EV battery performance and lifespan through effective management	Compare strategies for enhancing battery lifespan	Select strategies for enhancing battery lifespan	Effectively apply techniques to enhance battery life span	20

techniques.				
Integration of IoT for Battery Status	Identifying IoT implementation strategies	Perform Remote Monitoring and Data Acquisition to monitor the battery status	Implement IoT strategies effectively and monitor the real time health status	20