



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Industry Led Minor/Hons.

Level: UG

Branch: Electric Vehicles

Subject Code : BE05IAT011

Subject Name :Battery System and Energy Management
in Electric Vehicles

w. e. f. Academic Year:	2026-27
Semester:	5th
Category of the Course:	Core course

Prerequisite:	Fundamentals of mechanical & electrical engineering. Open to all streams
Rationale:	This course introduces learners to the core systems of Electric Vehicles, encompassing technology evolution, electrical architecture, powertrain, and safety standards. By bridging electrical and mechanical fundamentals, it builds the technical understanding required to design, analyze, and simulate EV subsystems—skills directly relevant to careers in automotive engineering, e-mobility, and advanced vehicle technology development.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Explain the fundamentals of battery chemistry, voltage–capacity behavior, and performance parameters influencing EV range and efficiency.	2
02	Illustrate the design progression from cell → module → pack, including configuration, balancing, and cooling requirements.	2
03	Describe and analyze the architecture and key functions of Battery Management Systems (BMS) for monitoring, protection, and control.	4
04	Perform basic testing and diagnostic procedures for evaluating battery capacity, thermal behavior, and safety compliance.	3
05	Apply principles of energy management to interpret SOC, SOH, and SOE data and optimize charging/discharging profiles.	3,4
06	Design and simulate a conceptual EV battery pack or subsystem integrating electrical, thermal, and safety considerations.	6

*Revised Bloom's Taxonomy (RBT)



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Teaching and Examination Scheme:

Teaching Scheme (in Hours/week)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
04	00	02	5	100	00	00	00	100

*Total Lecture Hrs. (L) =60 | Total Practical Hrs. (PR) =30. | Total Hours =90 Hrs

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Battery Fundamentals: <ul style="list-style-type: none">• Cell chemistry & datasheet reading,• voltage–capacity characteristics,• energy density.	5	10%
2.	Cell → Module → Pack Design: <ul style="list-style-type: none">• Configuration,• balancing,• interconnections,• cooling mechanisms.	15	15%
3.	Battery Management System (BMS) Basics: <ul style="list-style-type: none">• Functions,• architecture,• protection circuitry.	25	25%
4.	Battery Testing & Diagnostics: <ul style="list-style-type: none">• Capacity,• thermal and safety testing;• test protocols and standards.	15	20%



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5.	Energy Management & Efficiency: <ul style="list-style-type: none"> • SOC, • SOH, and • SOE estimation. • charging and discharging profiles. 	10	10%
6.	Thermal Management Techniques: <ul style="list-style-type: none"> • Air, liquid, and PCM cooling. • heat generation analysis. 	20	20%
Total		90	100%

Suggested Specification Table with Marks :

Distribution of Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
5	15	15	20	20	25

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

Skill & Practical Activities to be carried out during Semester

Important Note:- Please keep only applicable categories relevant to your offerings in this table and delete not applicable categories“

Sr. No.	Category of Engagement	Describe the activities to be carried out by students in brief	Expected Frequency & Duration	Mode of Delivery (Online / Offline / Hybrid)	Tools / Platforms / Equipment / Machinery to be Used	Expected major Learning Outcomes in 2 or 3 bullet points
1	Projects / Industry Assignments	Mini project based on Unit 6: thermal modelling, cell-module prototype, or BMS-controlled test setup	1 Project / 20 Hours	Hybrid / Offline	MATLAB/Simulink, small battery modules	<ul style="list-style-type: none"> • Apply battery system concepts • End-to-end understanding of pack behavior
2				Offline		



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	Tutorials / Guided Technical Sessions	<ul style="list-style-type: none"> • Unit 1 – Cell chemistry comparison & calculation tasks • Unit 2 – Configuration design (series–parallel mapping) • Unit 3 – BMS function mapping • Unit 5 – SOC/SOH estimation exercises 	Weekly / 1–2 Hours		Worksheets, design sheets	<ul style="list-style-type: none"> • Strengthen analytical and design skills • Improve conceptual clarity
3	Master Classes / Expert Lectures by Industry Professionals	Industry sessions on BMS protection, cell technology evolution, and thermal management (Units 1, 3, 6)	1 or 2 Sessions / 2 Hours Each	Hybrid	Webinar platform	<ul style="list-style-type: none"> • Exposure to industry standards • Real-world battery engineering insights
4	Hackathons / Ideathons	Unit 2 & 6 challenge: “Design an efficient battery pack layout with optimal cooling strategy”	1 Event / 6–8 Hours	Offline / Hybrid	whiteboarding tools	<ul style="list-style-type: none"> • Innovation in pack design • Team-based engineering creativity
5				Offline		



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	Case Studies / Bootcamps / Workshops	<ul style="list-style-type: none"> • Unit 1: Cell failure and degradation case study • Unit 4: Battery testing workshop (capacity/thermal/safety demo) • Unit 6: Cooling technique comparison workshop 	2–3 Workshops / 3–4 Hours Each		Case sheets, thermal camera, test rigs	<ul style="list-style-type: none"> • Diagnose real battery issues • Apply standards-based testing
6	Quizzes / Competency-Based Evaluation	Unit-wise quizzes aligned to weightage	Bi-weekly / 30–45 Min	Online	LMS / Google Forms	<ul style="list-style-type: none"> • Track progress • Reinforce key learning outcomes
7	Hands-on Training / Lab Exercises / Tool-Based Learning	<ul style="list-style-type: none"> • Unit 1: Cell characteristic measurement • Unit 2: Series–parallel assembly & balancing demo • Unit 3: BMS wiring, fault simulation • Unit 4: Capacity, IR & thermal tests 	Weekly / 2–3 Hours	Offline	Cell tester, multimeter, IR meter, BMS kits	<ul style="list-style-type: none"> • Hands-on testing competence • Safe handling & measurement skills
8	Simulation-Based / Demonstration-		4–6 Sessions /	Hybrid	MATLAB/Simulink, Pack	<ul style="list-style-type: none"> • Understand system behavior



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	Based Learning Sessions	<ul style="list-style-type: none"> • Unit 3: BMS control simulation • Unit 5: SOC/SOH algorithm simulation • Unit 6: Thermal modeling & cooling simulation 	2 Hours Each		modeling software	digitally • Improve diagnostic skills
9	Equipment Familiarization / Machine Handling	Unit 4 & 6: cyclor usage, safety equipment handling, cooling setup familiarization	2-3 Sessions / 2 Hours Each	Offline	Battery testers, cooling rigs, PPE	<ul style="list-style-type: none"> • Safe operation of test equipment • Practical exposure to testing tools
10	Prototype Development / Capstone Build / Hardware Integration	Build a small module using cells + BMS + cooling mock-up (Units 2, 3, 6 integration)	1 Prototype / 15 Hours	Offline	Cells (18650/21700), BMS, connectors, cooling mock setup	<ul style="list-style-type: none"> • Pack-building basics • Subsystem integration skills
11	On-Site Industrial Visits / Shop-Floor Exposure / Live Demo	Visit to a battery manufacturing / testing facility covering Units 2, 3, 4	1 Visit / Full Day	Offline	Industry environment	<ul style="list-style-type: none"> • Exposure to real pack assembly • Understanding quality & test processes

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