NATURE SCIENCE FOUNDATION
Coimbatore – 641 004, Tamil Nadu

Course Title: Electric Vehicle Technology and Manufacturing	
Mode of Delivery: Physical Classroom Training	**Type of Learning:** Lectures, Industry Study, Case Study & Student Activity
Total Learning Hours: 60	**Total Marks:** 75

Prerequisites

Basic knowledge of electrical engineering, circuits, and mechanical engineering.

Learning Objectives

- To understand the principles behind Electric Vehicle (EV) technology.
- To explore various components used in electric vehicles, including batteries, motors and controllers.
- To analyze the design and manufacturing processes involved in EV production.
- To evaluate the environmental and economic impacts of electric vehicles.
- To comprehend the challenges in EV infrastructure and charging systems

Learning Outcomes

On successful completion of the course, the students will be able to attain below Learning Outcome (LO):

Learning Outcome		CL	Linked PO	Teaching Hours
LO1	Explain the basic principles of Electric Vehicle technology.	***R, U***	**1,2,5,6,7,8,9, 10**	**12**
LO2	Illustrate the key components of electric vehicles, including batteries, motors, and controllers.	***U, A***	**1,2,4,5,6,8,9, 10**	**12**
LO3	Understand the electric vehicle design and manufacturing processes.	***R, U***	**1,2,3,4,5,6,10**	**06**
LO4	Assess the economic and environmental impacts of electric vehicles.	***U, A***	**1,2,5,6,8,9,10**	**08**
LO5	Evaluate the challenges and solutions for electric vehicle charging infrastructure.	***U, A***	**1,2,5,6,8,9,10**	**08**
LO6	Case Study and Student Activity	***U, A***	**1,2,5,6,7,9,10**	**14**
			Total	**60**

Legends: CL = Cognitive Level, R = Remember, U= Understand, A= Apply and above levels (Bloom's Revised Taxonomy)

Learning - LO Attainment Matrix

Learning	Learning Outcomes									
	1	2	3	4	5	6	7	8	9	10
Electric Vehicle Technology and Manufacturing	**3**	**3**	**1**	**2**	**3**	**3**	**2**	**3**	**3**	**3**

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

- Method is to relate the level of LO with the number of hours devoted to the LOs which address the given LO.
- If >40% of classroom sessions addressing a particular LO, it is considered that LO is addressed at Level 3
- If 25 to 40% of classroom sessions addressing a particular LO, it is considered that LO is addressed at Level 2 If 5 to 25% of classroom sessions addressing a particular LO, it is considered that LO is addressed at Level 1
- If < 5% of classroom sessions addressing a particular LO, it is considered that LO is considered not-addressed.

Learning Content and Blue Print of Marks for External

Unit No	Unit Name	Hour	Questions to be set for External			Marks Weightage	Marks Weightage (%)
			R	U	A	A	
I	Introduction to Electric Vehicles	**12**	5	20	10	35	24.13
II	EV Components and Systems	**12**	-	20	10	30	20.68
III	EV Manufacturing Processes	**06**	5	10	-	15	10.35
IV	Charging Infrastructure and Energy Management	**08**	-	10	15	25	17.24
V	Future Trends and Challenges in EVs	**08**	-	15	10	25	17.24
VI	Industry Study, Case Study & Student Activity	**14**	-	15	-	15	10.35
	Total	**60**	**10**	**90**	**45**	**145**	**100**

UNIT I: Introduction to Electric Vehicles **12 Hrs**

Definition , Overview, History and Evolution of electric vehicles, Importance of EVs in the automotive industry and environment, Types of EVs: BEVs, HEVs, PHEVs, FCEVs, and their applications, Basic EV Components and Architecture : Electric motors, batteries, inverters, and chargers, Overview of drivetrain components: Motor, controller, and transmission, Charging systems: AC charging, DC fast charging, Global Trends in EV Adoption: Global Trends in EV Adoption, Government policies, incentives, and regulations, Market trends, demand, and challenges and EV Performance and Efficiency : Range, charging time, and power management, Energy consumption and efficiency metrics.

UNIT II: EV Components and Systems **12 Hrs**

Battery technologies - Types of EV batteries: Lithium-ion, Solid-state, Lead-acid, and emerging technologies, Key parameters and Battery pack design, Energy storage systems and battery management systems - Functions of BMS & Thermal Management, Electric motors: Types of motors, Motor characteristics, power electronics, and drive systems. Regenerative braking and energy recovery techniques and its uses.

UNIT III: : EV Manufacturing Processes **06 Hrs**

Material Selection and Design Considerations for EVs: Lightweight Materials, Battery Materials, Design considerations: Weight Reduction, Safety Design, Sustainability, Design for Manufacturability: Modular Design and Ease of Assembly, Assembly Processes for EVs: Powertrain Components, Battery Pack Assembly, Motor and Transmission Integration. Integration of electrical (Wiring and Connectors, Control System, & Charging system) and mechanical systems(Powertrain Assembly and Integration, Suspension and Brake Systems, Thermal Management Systems). Role of automation and robotics in EV manufacturing. Safety standards and quality assurance in production.

UNIT IV: Charging Infrastructure and Energy Management **08 Hrs**

Charging technologies& its basics, types of chargers: Level 1 Charging (AC), Level 2 Charging (AC), level 3 Charging (DC Fast Charging), Ultra-Fast Charging, Charging standards: IEC 61851, CHAdeMO, Combined Charging System (CCS), Tesla Supercharger, Wireless Charging, Grid integration - Vehicle-to-Grid (V2G) Technology, energy distribution, and smart charging systems- Communication between EVs and Charging Stations , Dynamic Charging. Challenges in infrastructure development and solutions: Limited Charging Stations, Limited Charging Stations, Charging Speed and Range Anxiety, Grid Capacity and Load, Expansion of Charging Networks, Grid

UNIT V: Future Trends and Challenges in EVs **08 Hrs**

Upgrades and Smart Grids, Standardization and Open Networks, Public-Private Partnerships & Wireless Charging. Emerging technologies such as solid-state batteries and wireless charging (Overview, Advantages, Challenges, Current Research and Future prospects. Autonomous electric vehicles and connected mobility (Overview, Integration, Key Technologies, Challenges). Challenges related to cost, scalability, and

environmental sustainability. Policies and incentives for promoting EV adoption (Government Incentives, Infrastructure Development support, Global EV Initiatives).

UNIT VI: Industry Study, Case Study & Student Activity 14 Hrs

Student Industry Visit - Real-world Case Studies Demonstrating the Applications of EV – Hands-on Projects and Exercises for Implementation and Practice.

References

- Electric Vehicle Technology Explained by James Larminie and John Lowry, 2nd Edition, Wiley, 2012.
- Modern Electric, Hybrid Electric, and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, 3rd Edition, CRC Press, 2018.
- Electric and Hybrid Vehicles: Technologies, Modeling, and Control by Amir Khajepour, Saber Fallah, and Avesta Goodarzi, Wiley, 2014.
- Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives by Chris Mi, M. Abul Masrur, and David Wenzhong Gao, 2nd Edition, Wiley, 2017.
- Manufacturing Processes for Engineering Materials by Serope Kalpakjian and Steven R. Schmid, 6th Edition, Pearson, 2016.

Suggested list of student activities

Note: the following activities or similar activities for assessing Internal for 5 marks

1. Each student should do any one of the following type activity or any other similar activity related to the course and before conduction, get it approved from concerned learning coordinator
2. Each student should conduct different activity and no repeating should occur.

1	Understand the overview of Electric Vehicle (EV) Charging Protocols.
2	Explore and Understand EV Battery Technologies.
3	Research on EV Manufacturing Process
4	Study the Role of Electric Motors in EVs
5	Evaluate the Environmental Impact of Electric Vehicles.
6	Investigate the Role of Regenerative Braking Systems in EVs
7	Design and simulate an EV Charging Station Setup
8	Quiz

Case Study

• Designing an Electric Vehicle: Conceptualizing the Architecture, Battery System, and Powertrain

• Battery Management System for Electric Vehicles: Developing a Model for Optimized Battery Performance and Safety

• Building a Sustainable EV Manufacturing Process: Analyzing Environmental Impact and Waste Reduction Techniques

• Developing a Charging Network Plan: Designing and Implementing a Charging

Infrastructure for Urban Areas

• EV Performance Optimization: Comparing Energy Efficiency and Driving Range Across Different EV Models

• Consumer Adoption of Electric Vehicles: A Case Study on Market Trends and Consumer Preferences

• Electric Vehicle Maintenance System: Designing a Diagnostic Tool for EV Battery Health and Performance

• Renewable Energy Integration for EV Charging Stations: A Sustainable Power Solution for the EV Ecosystem

• Autonomous Electric Vehicles: Investigating the Integration of Self-Driving Technology in EVs

• Future of Electric Vehicles: Exploring the Potential of Wireless Charging and Hydrogen-Based EVs

Learning Assessment and Evaluation Scheme

<table>
<tr><th>Method</th><th colspan="2">What</th><th>To whom</th><th>When/Where (Frequency in the course)</th><th>Max Marks</th><th>Evidence collected</th><th>Learning outcomes</th></tr>
<tr><td rowspan="4">Direct Assessment</td><td rowspan="3">External</td><td rowspan="3">Internal</td><td rowspan="4">Students</td><td>Three Internal tests (Average of three tests will be computed)</td><td>20</td><td>Blue books</td><td>1 to 6</td></tr>
<tr><td>Student activities</td><td>10</td><td>Report</td><td>1 to 6</td></tr>
<tr><td>Total</td><td>30</td><td></td><td></td></tr>
<tr><td>End Semester</td><td>End Exam</td><td>End of the Learning</td><td>70</td><td>Answer scripts</td><td>1 to 6</td></tr>
<tr><td rowspan="2">Indirect Assessment</td><td colspan="2">Student Feedback on course</td><td rowspan="2">Students</td><td>Middle of the Learning</td><td></td><td>Feedback forms</td><td>1,2,3 Delivery of course</td></tr>
<tr><td colspan="2">End of Learning Survey</td><td>End of the Learning</td><td></td><td>Questionnaires</td><td>1 to 6 Effectiveness of Delivery of instructions & Assessment Methods</td></tr>
</table>

Note: Internal Evaluation shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Questions for Internal and External will be designed to evaluate the various educational components (Bloom's taxonomy) such as:

Sl. No	Bloom's Category	%
1	Remembrance	07
2	Understanding	62
3	Application	31

Note to Internal verifier*: *The following documents to be verified by Internal verifier at the end of semester

1. Blue books (20 marks)
2. Student suggested activities report for 10 marks
3. Student feedback on learning regarding Effectiveness of Delivery of instructions & Assessment Methods.

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
			20
	Year:		
Name of Learning coordinator : Units:_ LO's:_____			

Question no	Question	MARKS	CL	LO	LO
1					
2					
3					
4					

Note: Internal choice may be given in each LO at the same cognitive level (CL).

MODEL QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
		Electric Vehicle Technology and Manufacturing	20
	Year:		
Name of Course coordinator: Units:1,2 Co: 1,2 **Note: Answer all questions**			

Question no	Questions	CL	CO	PO
1	Discuss the evolution and importance of Electric Vehicles (EVs) (5M) **OR** What are the key advantages of Electric Vehicles over traditional internal combustion engine vehicles? (5M)	U	1	1,2

2	Discuss current global trends in the Electric Vehicle market. (5M)	R	1	1,2
3	Discuss the environmental benefits of Electric Vehicles. (10M) **OR** Explain the importance of battery recycling in Electric Vehicles. (10M)	A	2	1,2

Note: Internal choice may be given in each LO at the same cognitive level (CL).

Format for Student Activity Assessment

DIMENSION	Unsatisfactory 1	Developing 2	Satisfactory 3	Good 4	Exemplary 5	Score
Collection of data	Does not collect any information relating to the topic	Collects very limited information; some relate to the topic	Collects some basic information ; refer to the topic	Collects relevant information; concerned to the topic	Collects a great deal of information; all refer to the topic	3
Fulfill team's roles & duties	Does not perform any duties assigned to the team role	Performs very little duties	Performs nearly all duties	Performs all duties	Performs all duties of assigned team roles with presentation	4
Shares work equally	Always relies on others to do the work	Rarely does the assigned work; often needs reminding	Usually does the assigned work; rarely needs reminding	Does the assigned job without having to be reminded.	Always does the assigned work having to be reminded and on given time frame	3
Listen to other Team mates	Is always talking; never allows anyone else to speak	Usually does most of the talking; rarely allows others to speak	Listens, but sometimes talk too much	Listens and contributes to the relevant topic	Listens and contributes precisely to the relevant topic and exhibit leadership qualities	3
					TOTAL	**13/4=3.25=4**

Note: This is only an example. Appropriate rubrics/criteria may be devised by the concerned Learning Coordinator for assessing the given activity

MODEL QUESTION BANK

Course Title: Electric Vehicle Technology and Manufacturing

LO	Question	CL	Marks
I	What is the evolution of Electric Vehicles (EVs) over the years?	R	05
	What are the different types of Electric Vehicles (EVs)?	A	
	What are the advantages of Electric Vehicles over conventional internal combustion engine vehicles?	U	
	How do Electric Vehicles contribute to environmental sustainability?	U	
	Describe the basic architecture of an Electric Vehicle.	U	
	What are the key components of an Electric Vehicle's architecture?	U	
	How do Battery Electric Vehicles (BEVs) differ from Plug-in Hybrid Electric Vehicles (PHEVs)?	U	
	Explain the role of the electric motor in Electric Vehicles.	U	
	What are the benefits of using Lithium-Ion batteries in Electric Vehicles?	U	
	What are the major environmental impacts of conventional vehicles that EVs help mitigate?	R	
	Discuss the role of regenerative braking in Electric Vehicles.	A	10
	What are the key drivers behind the growing adoption of Electric Vehicles globally?	A	
	How do Electric Vehicles reduce greenhouse gas emissions compared to traditional vehicles?	U	
	Explain the current market trends for Electric Vehicles.	U	
	What are the challenges faced by the Electric Vehicle industry today?	U	
	Describe the classification of Electric Vehicles based on powertrain types.	U	
II	What are the different types of battery technologies used in Electric Vehicles (EVs)?	A	5
	Explain the role of energy storage systems in Electric Vehicles.	A	
	What is a Battery Management System (BMS) and why is it important in Electric Vehicles?	A	
	How do Lithium-Ion batteries work in Electric Vehicles?	A	
	What are the advantages of using Lithium-Ion batteries over traditional lead-acid batteries in EVs?	A	
	Describe the role of electric motors in Electric Vehicles.	U	
	What are the different types of electric motors used in Electric Vehicles?	A	10
	Explain how power electronics are used in Electric Vehicles to control the motor.	A	
	What is the function of the drive system in an Electric Vehicle?	U	
	How does regenerative braking work in Electric Vehicles?	A	
	What are the benefits of regenerative braking and energy recovery in Electric Vehicles?	A	

	Explain the role of power inverters and converters in an Electric Vehicle's powertrain system.	**A**	
III	What factors are considered in material selection for Electric Vehicles?	**U**	**5**
	Why is lightweight material important in EV design?	**R**	
	How does EV design differ from conventional vehicle design?	**R**	
	What is the typical assembly process for Electric Vehicles?	**U**	
	How are electrical and mechanical systems integrated in EVs?	**U**	
	What role does automation play in EV manufacturing?	**U**	
	How is robotics used in EV production?	**U**	
	What safety standards are followed in EV manufacturing?	**U**	**10**
	How is quality assurance ensured in EV production?	**U**	
IV	Explain purpose and requirement specification of IoT Design.	**U**	**5**
	Describe Process specifications for Home Automation IoT Systems.	**A**	
	Describe information Model of the Home automation IoT Systems.	**A**	
	Explain Controller service of Home Automation IoT System.	**A**	
	Explain Operational view specification with an example.	**U**	
	List and Briefly explain the steps involved in IoT System Design Methodology.	**U**	**10**
	Explain Domain Model of the Home automation IoT system.	**A**	
	Derive the services from process and information model for Home automation IoT System.	**A**	
	Explain functional view specification for Home Automation IoT System.	**A**	
V	What are the different types of Electric Vehicle chargers?	**U**	**5**
	Explain the various charging technologies used for Electric Vehicles.	**A**	
	What are the standard charging protocols used for Electric Vehicles?	**A**	
	How is grid integration important for Electric Vehicle charging infrastructure?	**U**	
	What is the role of energy distribution in EV charging networks?	**U**	
	What is a smart charging system, and how does it benefit EV users?	**U**	
	What are the challenges in developing Electric Vehicle charging infrastructure?	**A**	**10**
	How can smart grids help optimize the charging of Electric	**U**	
VI	What are some case studies showcasing the use of Electric Vehicles in the industry?	**U**	**5**
	How do industry visits provide hands-on experience in EV manufacturing?	**U**	
	What practical exercises can students do to learn about EV assembly?	**A**	
	How do industry visits help students understand battery integration in EVs?	**A**	
	What role do students play during an EV production industry visit?	**U**	

	How are automation and robotics used in EV production, based on case studies?	**U**	
	What challenges in EV manufacturing can be explored during an industry visit?	**U**	**10**
	How do industry visits enhance students' understanding of EV technology applications?	**A**	