ANNEXURE I

TABLE 1: MODULE WISE COURSE CONTENT AND OUTCOME				
S.No	**MODULE NAME**	**MODULE CONTENT**	**MODULE LEARNING OUTCOME**	**DURATION (HRS)**
1	**Electric Powertrain Fundamentals**	• Overview of EV technology and its benefits • Comparison between conventional and electric vehicles • Key components of an EV powertrain • Basic operation of an EV powertrain Environmental and social benefits of electric vehicles • Basic components of electric vehicles (battery, motor, power electronics) • An exploration of the environmental and economic advantages of EVs. • Power electronic converters (inverters, rectifiers, DC-DC converters) • Power semiconductor devices (IGBTs, MOSFETs) • Inverter topologies (two-level, three-level, multilevel) • Inverter control strategies (PWM techniques) • Power losses and efficiency considerations	• Understand EV Basics • Explain the fundamental principles of electric vehicle operation. • Compare and contrast conventional and electric vehicles. • Identify the key components of an EV powertrain. • Differentiate between various types of electric motors. • Understand the working principles of electric motors. • Analyze motor performance characteristics • Explain motor control techniques and their applications. • Master Power Electronics • Understand the role of power electronics converters in EV powertrains. • Explain the operation of power semiconductor devices. • Analyze	9 Hrs

			different inverter topologies and their advantages. • Understand inverter control strategies and their impact on motor performance. • Evaluate power losses and efficiency considerations in power electronics.	
2	**VEHICLE CONTROL SYSTEMS**	• Vehicle dynamics and control principles • Traction control systems • Stability control systems • Energy-efficient driving strategies • Basic principles of vehicle dynamics • Vehicle coordinate systems and reference frames • Vehicle models (linear and nonlinear) • Vehicle Stability and Control • Vehicle stability analysis (static and dynamic) • Vehicle handling characteristics (understeer, oversteering)	• Voltage, current, and temperature sensing and their importance in BMS operation. • Explain the fundamental principles of battery operation. • Differentiate between various battery technologies (Li-ion, Ni-MH, etc.) in terms of energy density, power density, and cycle life. • Analyze the charging and discharging characteristics of batteries. • Evaluate the impact of battery thermal management systems on battery performance and safety. • Explain the	9 Hrs

			working principles of different types of electric motors (AC induction, DC brushless, PMDC). • Analyze the performance characteristics of electric motors in terms of efficiency, torque, and speed. • Understand the role of power electronics in controlling the speed and torque of electric motors. • Evaluate the impact of motor control strategies on vehicle performance and energy efficiency. • Explain the operation of power electronic devices (diodes, transistors, IGBTs).	
3	**INTEGRATION OF EV POWERTRAIN**	• Placement of battery packs, motors, and controllers within the vehicle chassis. • Lightweight Materials: Use of advanced materials to improve efficiency and integration (e.g., aluminum, carbon composites). • Chassis Design: Modifications for	• Explain the challenges and considerations involved in integrating various components of an EV powertrain. • Analyze the impact of component interactions on overall system performance.	9 Hrs

		electric architecture, impact on handling and safety. • HVAC Integration: Energy-efficient heating and cooling systems integrated with the battery and cabin systems.	• Identify potential integration issues and propose solutions. Understand Vehicle • Dynamics a thorough understanding of vehicle dynamics principles, including vehicle coordinate systems, reference frames, and the basic operation of vehicle models. • Analyze Stability and Control Apply knowledge of stability control systems to • Analyze and interpret vehicle stability in both static and dynamic conditions. • Design efficient and compact powertrain layouts. • Optimize component placement for weight distribution, cooling, and accessibility. • Consider packaging constraints and manufacturing considerations. • Use simulation tools to model	

			and analyze the integrated EV powertrain system. • Predict the performance and efficiency of the integrated system.	
4	**CHARGING INFRASTRUCTURE AND BATTERY MANAGEMENT**	• Charging Infrastructure: An analysis of different charging infrastructure types (AC, DC, wireless) and their impact on EV adoption. • Battery Management Systems (BMS): A deep dive into BMS functions, including cell balancing, state-of-charge estimation, and thermal management. • Fast Charging Technologies: An exploration of fast-charging techniques and their impact on battery life. • Battery Health Monitoring: A discussion of techniques for monitoring battery health and predicting battery life. • Battery Management Systems (BMS): • Role of BMS in extending battery life • Optimal charging and discharging strategies • Second-Life	• Understand Vehicle Dynamics a thorough understanding of vehicle dynamics principles, including vehicle coordinate systems, reference frames, and the basic operation of vehicle models (linear and nonlinear). • Analyze different types of charging infrastructure and their influence on the adoption and usability of EVs. • Understand the functions of Battery Management Systems (BMS), including cell balancing, state-of-charge estimation, and thermal management. • Examine fast-charging technologies, their impact on battery life, and their role in	9 Hrs

		Applications for Batteries: • Stationary energy storage	improving charging convenience. • Apply techniques for monitoring battery health, predicting battery life, and optimizing battery usage for long-term performance. • dynamics and control principles to enhance vehicle performance. • Explain the role of BMS in monitoring and managing battery performance. • Discuss optimal charging and discharging strategies to extend battery life and improve overall performance.	
5	**Future Trends and Technologies**	• Emerging technologies in electric vehicles (solid-state batteries, fuel cells) • Infrastructure requirements for electric vehicles (charging stations) • Challenges and opportunities in the electric vehicle industry • Policy and regulatory frameworks for electric vehicles • Consumer Awareness and Education:	• Understand Advanced Battery Technologies • Explain the principles and advantages of solid-state batteries. • Explain the advancements in electric vehicle technologies, including solid-state batteries and fuel cells, and their potential impact on the industry.	9 Hrs

		• The role of consumers in sustainable battery use and disposal • Promoting responsible EV ownership and battery recycling.	• Analyze Infrastructure Needs Assess the infrastructure requirements for electric vehicles. • Identify Industry Challenges and Opportunities Evaluate the challenges and opportunities within the electric vehicle industry. • Promote Consumer Awareness Develop strategies to enhance consumer awareness and education about the benefits of electric vehicles and their role in achieving sustainable transportation. • Advocate for Sustainability Practices Highlight the importance of responsible EV. • Encourage Collaboration for Sustainable Solution Foster discussions on collaborative efforts among stakeholders to address EV-related challenges.	

ANNEXURE II

TABLE 2: OVERALL COURSE LEARNING OUTCOME ASSESSMENT CRITERIA AND USECASES			
LEARNING OUTCOME	**ASSESSMENT CRITERIA**	**PERFORMANCE CRITERIA**	**USECASES**
• Students will be able to describe the evolution of electric and hybrid vehicles, identifying key technological milestones and innovations in EV and HEV development. • Technological Awareness Students will gain an understanding of major advancements in battery technologies and the impact of these innovations on the adoption and performance of EVs and HEVs. • Critical Analysis Students will critically evaluate the societal and environmental factors that have influenced the development and commercialization of EVs and HEVs. • Interactive Learning Students will learn how to engage with interactive tools for exploring historical data and trends, enhancing their	• Clear explanation of Permanent Magnet Synchronous Motors (PMSM) and their advantages over AC Induction Motors. • Efficiency Comparison In-depth analysis of efficiency differences between PMSM, AC Induction Motors, and BLDC motors. • Performance Impact Demonstration of how torque delivery and power efficiency are enhanced in PMSM and BLDC motors. • Visual Design timeline should be visually appealing with high-quality images, icons, or videos to enhance the user experience. • Interactivity user should be able to interact with the timeline (e.g., click on milestones for more information or view multimedia content related to events). • Educational Value The timeline should be informative, providing both technical and social context for each milestone. • Technical Execution	• Efficiency: Maximize motor efficiency across the full operating range. • Power-to-weight ratio: High output while maintaining a lightweight design. • Durability: Longevity under continuous high-performance conditions. • Thermal stability: Efficient heat dissipation to maintain optimal performance • Torque generation: High starting torque and quick response times. • Speed range: Broad operational speed range with minimal power losses. • Control efficiency: Precise control using advanced inverters and software. • Reliability: Resistance to mechanical wear and high thermal loads. • Energy density: Maximize watt-hour per kilogram (Wh/kg). • Charge/discharge cycles: Longer cycle life without significant capacity loss.	1. Electric Motor Optimization in EVs Scenario: Manufacturers of EVs are constantly improving the efficiency and performance of electric motors. Companies like Tesla and General Motors are utilizing advanced algorithms to optimize torque delivery in motors for enhanced driving range and acceleration TASK: Research how Tesla's use of permanent magnet synchronous motors (PMSM) 2. AC Induction Motor in High-Performance EVs

research and presentation skills. • Describe the evolution of electric and hybrid vehicles, identifying key technological milestones and innovations. • Gain an understanding of major advancements in battery technologies and their impact on EV and HEV performance. • Critically evaluate societal and environmental factors influencing the development and commercializatio n of EVs and HEVs. • Engage with interactive tools for exploring historical data and trends, enhancing research and presentation skills.	The timeline should function smoothly without glitches or performance issues. • Understanding of how these motors contribute to acceleration and range in high-performance vehicles like the Tesla Model S. • Comparative Analysis Clear comparison between AC induction motors and traditional automotive engine systems, focusing on performance and efficiency. • Practical Application Insight into how AC induction motors are integrated into the EV architecture and their contribution to vehicle dynamics.	• Safety: Reduced risk of thermal runaway or hazardous failures. • Sustainability: Use of abundant, low-impact materials. • Accuracy: Precise state-of-charge (SOC) and state-of-health (SOH) estimation. • Thermal regulation: Efficient heat management to avoid degradation. • Energy balancing: Uniform distribution of charge across cells. • Scalability: Flexibility to adapt to different battery pack sizes.	Scenario: AC induction motors are used in the Tesla Model S and other high-performance EVs for their high power output, scalability, and robustness. TASK: Analyze how the characteristics of AC induction motors contribute to the high acceleration and range 3 . Battery Chemistry Development by EV Manufacturers Scenario: EV manufacturers like Nissan, Tesla, and BYD are working on new battery chemistries to reduce cost, increase energy density, and improve longevity TASK: Research the evolution of lithium-ion (Li-ion) and solid-state batteries, and

			how these innovations are integrated into EV powertrains 4. Battery Management in EVs Scenario: Companies like BMW and Volkswagen integrate advanced Battery Management Systems (BMS) to monitor and optimize battery life and performance. TASK: Develop a simulation that models battery charging cycles
• 2. Students will be able to explain the function of motor controllers in regulating torque and speed for electric vehicles under various driving conditions. • They will understand the role of motor controllers in optimizing vehicle performance, including acceleration, braking, and energy efficiency. • Control Algorithm Comparison	• Understanding of Motor Controllers: Clear explanation of the role of motor controllers in regulating torque and speed under various driving conditions. • Control Algorithm Comparison: In-depth comparison of torque and speed control algorithms used by Tesla, Rivian, and other mainstream EV manufacturers. • Impact on Battery Usage: Analysis of how different motor control strategies	• Cooling performance: Maintain battery and motor temperature within optimal ranges. • Energy efficiency: Minimal impact on overall power consumption. • Adaptability: Effective in extreme weather conditions. • Compactness: Small form factor to enhance powertrain packaging. • Responsiveness: High-precision adjustments in real-time. • Energy efficiency:	1. Torque and Speed Control with Motor Controllers Scenario: EV manufacturers implement sophisticated motor controllers to fine-tune motor performance, especially under different driving conditions. TASK: Develop a

• Students will gain the ability to compare and contrast different motor control algorithms used in mainstream EVs, such as Tesla, Rivian, and other manufacturers. • They will be able to evaluate the strengths and weaknesses of key control strategies, such as field-oriented control (FOC), direct torque control (DTC), and other advanced control techniques, and how these algorithms contribute to vehicle performance. • Students will learn how different motor control strategies directly influence battery usage and energy efficiency in EV.	(e.g., field-oriented control, direct torque control) optimize battery usage, increase efficiency, and extend driving range. • Real-time Control and Adaptation: Understanding of how motor controllers adapt to driving modes like sport, eco, and comfort. • Practical Applications: Insight into how these algorithms are implemented in real-world EV systems, with practical examples and performance results. • Ability to maintain optimal cell temperature within safe limits. • Efficient dissipation of heat generated during charging and discharging. • Minimization of temperature differences between cells.	Optimize performance with minimal power usage. • Compatibility: Support for multiple drive modes (e.g., eco, sport). • Safety: Protection against overcurrent or voltage fluctuations. • Data accuracy: Real-time monitoring with minimal error margin. • Alert mechanisms: Early detection of faults or inefficiencies. • Integration: Compatibility with EV subsystems like powertrain or HVAC. • User interface: Clear, actionable insights for drivers or operators. • Fuel efficiency: Optimize usage of both battery and ICE (internal combustion engine). • Seamless transitions: Smooth switching between energy sources. • Predictive capabilities: Use driving patterns to pre-adjust energy distribution. Driver-selectable energy modes.	comparison of torque and speed control algorithms used in mainstream EVs and how they optimize battery usage.. 2. Real-time Battery Monitoring with BMS Scenario: Companies like Tesla use advanced BMS to continuously monitor the state of charge (SOC) and state of health (SOH) to ensure safe operation and extend battery life TASK: Research the development of real-time SOC and SOH estimation methods 3. Adaptive Energy Management in Hybrid EVs Scenario: Toyota's Prius uses sophisticated energy management systems (EMS) to dynamically adjust power

			distribution between the battery and internal combustion engine (ICE) in hybrid EVs. Task: Analyze Toyota's EMS strategy in hybrid vehicles and its impact on fuel efficiency 4. Drive Mode Optimization in EVs. Scenario: Modern EVs such as the BMW i3 feature multiple drive modes (eco, sport, comfort), which adjust performance parameters to balance energy consumption and driving experience TASK: Design a sensor network to accurately measure battery cell voltages, currents, and temperatures.
• 3.Analyze the challenges associated with separating different battery	• Emissions Evaluate emissions of pollutants such as particulate matter, nitrogen oxides,	• Performance tuning: High torque in performance modes and extended range in eco modes.	1. EV Powertrain Packaging and Layout conditions.

materials • Identify Separation and Sorting Challenges • Describe the difficulties in separating and sorting battery components, including cells, modules, and individual materials • Evaluate the impact of battery degradation on recycling processes • Assess Low Recycling Efficiency and Recovery Rates • Analyze the factors limiting the efficiency of current recycling technologies • Discuss the economic and technical barriers to achieving high recovery rates • Evaluate the Economic Viability of Recycling • Assess the cost-effectiveness of various recycling processes • Identify strategies to improve the economic viability of battery recycling • Understand the Risks Associated with Toxicity and Hazardous Materials:	sulfur dioxide, and volatile organic compounds. • Air Dispersion Modeling Assess the dispersion of pollutants and their impact on ambient air quality. • Control Measures Evaluate the effectiveness of pollution control technologies. • Understanding of the impact of battery degradation on recycling processes • Material Recovery Rate The ability to recover valuable materials (e.g., lithium, cobalt, nickel) from spent batteries with high efficiency. • Energy Efficiency The energy consumption of the recycling process, aiming to minimize energy usage and reduce the carbon footprint. • Environmental Impact The overall environmental impact of the recycling process, including emissions, water usage, and waste generation. • Process Reliability and Scalability The robustness and scalability of the recycling process to handle large volumes of spent batteries. • The safety of	• Dynamic adjustment: Automatic mode shifts based on driving conditions. • Energy savings: Reduce unnecessary power consumption in low-demand scenarios. • User engagement: Intuitive settings to enhance driving experience. • Space efficiency: Optimal arrangement of components for compactness. • Weight distribution: Balance for improved handling and stability. • Scalability: Designs adaptable to different vehicle models. • Ease of assembly: Streamlined production and maintenance. • Weight reduction: Minimize mass while maintaining structural integrity. • Cost-effectiveness: Use of materials that balance performance and affordability. • Corrosion resistance: Prolong lifespan in various environments. • Recyclability: Use of materials that are easy to repurpose or recycle. • Energy efficiency: Reduce power consumption while maintaining	Scenario: Automakers like Audi and Mercedes-Benz have focused on efficient packaging of EV powertrains, with motors, batteries, and controllers integrated into the chassis to reduce weight and optimize space TASK: Design a mock-up of an EV powertrain layout that minimizes space while ensuring efficient energy flow and cooling. 2. Lightweight Materials in EV Construction Scenario: EVs like the Tesla Model X and the Jaguar I-PACE have modified chassis designs to accommodate the unique layout of EV powertrains TASK: Analyze the impact of

• Explain the potential environmental and health risks associated with improper handling and disposal of battery materials • Discuss the importance of safe and environmentally sound recycling practices	workers involved in the recycling process, including protection from hazardous materials and working conditions.	comfort. • Thermal integration: Leverage waste heat from other systems (e.g., battery). • Compact design: Minimized space and weight impact. • User comfort: Rapid climate control with uniform distribution.	chassis design changes on vehicle handling, safety, and crash performance for modern EVs. 3. HVAC Systems Integration in EVs Scenario: Companies like Waymo and Cruise are integrating advanced EV powertrains with autonomous driving technology, optimizing power management based on real-time driving conditions. TASK: Investigate how powertrain systems in autonomous EVs must adapt to meet the demands of autonomous driving, with a focus on energy efficiency and system integration. 4.

			Autonomous EV Powertrain Integration Scenario: Companies like Waymo and Cruise are integrating advanced EV powertrains with autonomous driving technology, optimizing power management based on real-time driving conditions. and braking. TASK: Investigate how powertrain systems in autonomous EVs must adapt to meet the demands of autonomous driving.
• 4.Understand the Fundamentals of Lithium-ion Batteries • Evaluate different battery recycling technologies and their effectiveness in recovering valuable materials like lithium, cobalt, and nickel. • Explain the basic components and chemistry of lithium-ion	• Battery State-of-Charge (SOC) Estimation Accuracy • Accuracy of SOC estimation under various operating conditions (temperature, load, aging). • Responsiveness Speed of SOC estimation to changes in battery state. • Robustness Reliability of SOC estimation in the presence of noise	• Response time: Real-time coordination with autonomous sensors. • System redundancy: Backup mechanisms to ensure reliability. • Energy optimization: Efficient power usage during self-driving operations. • Integration: Seamless interaction with ADAS (Advanced	1.Develop a process to maximize the recovery of valuable metals from lithium-ion batteries using hydrometallurgical techniques. Scenario: As the demand for lithium-ion batteries grows due to

batteries. • Discuss the environmental and economic implications of improper battery disposal. • Analyze the challenges associated with recycling lithium-ion batteries, such as material complexity and safety concern • Critical Thinking and Problem Solving Enhance critical thinking by analyzing complex policy issues and understanding the trade-offs involved in regulatory changes.	and uncertainties. • Speed of balancing cells to equalize their state of charge. • Energy Efficiency Minimization of energy loss during cell balancing. • Precision Accuracy of cell voltage balancing. • Ability to maintain optimal cell temperature within safe limits. • Efficient dissipation of heat generated during charging and discharging. • Minimization of temperature differences between cells. • Incentives for producers to develop batteries that are easier to recycle. • Expand EPR programs to ensure manufacturers take more financial responsibility for battery collection and recycling. • Offer incentives for companies that use sustainable or recyclable battery materials. • Require manufacturers to meet design standards for easier disassembly and recycling.	Driver-Assistance Systems). • Predictive analytics: Accurate lifetime and performance predictions. • Learning models: Adaptive algorithms that improve over time. • Fault tolerance: Robust against data inaccuracies or system failures. • Energy optimization: Improved range and performance through smarter management. • Energy capacity: Achieve densities exceeding 400 Wh/kg. • Thermal safety: Minimized risks of overheating or combustion. • Cycle life: >1,000 cycles with less than 10% capacity loss. • Scalability: Feasibility for mass production. • Capacity utilization: Maximize residual energy use. • Cost-efficiency: Reduce storage costs compared to new systems. • Durability: Maintain performance in stationary applications. • Integration: Seamless connection to grid or renewable energy systems.	the increasing adoption of electric vehicles, electronics, and renewable energy storage systems, the need for sustainable recycling methods is crucial. Lithium-ion batteries contain valuable metals, including lithium, cobalt, nickel, and manganese, which can be recovered and reused. However, improper disposal of batteries can lead to environmental pollution, while inefficient recycling processes can waste valuable resources. The aim is to develop an optimized hydrometallurgical process that maximizes metal recovery, reduces environmental

	• Safety and Handling Standards • Guidelines for safe transportation and storage of batteries. • Regulations for recycling facility safety, especially for handling hazardous materials. • Standards for labeling batteries for easier identification and proper handling. • Update safety protocols to address new battery chemistries, such as lithium-ion and solid-state. • Require clear labeling to identify battery chemistry, ensuring appropriate handling procedures. • Offer incentives for		impact TASK: Develop a comprehensive process to maximize the recovery of valuable metals from lithium-ion batteries 2. Develop advanced BMS algorithms to optimize battery performance and extend lifespan. Scenario: Advanced Battery Management System (BMS) battery longevity and efficiency are crucial to reduce costs and increase vehicle range. Batteries degrade over time due to factors like temperature, charging habits, and high current loads. This degradation not only affects battery life but also leads to performance inefficiencies, reduced driving range, and higher replacement costs.

• 5.Promoting Sustainable Practices: Gain insight into the environmental and economic benefits of effective recycling programs and learn how policy can drive sustainable practices within industries. • Awareness of Technological and Industry Trends: Understand the role of innovation	companies that use sustainable or recyclable battery materials. • Require manufacturers to meet design standards for easier disassembly and recycling. • Safety and Handling Standards • Guidelines for safe transportation and storage of batteries. • Regulations for recycling facility safety, especially for handling hazardous materials. • Learn to classify electric vehicles based on driving habits, range, and charging needs. • Develop decision-making frameworks to assist in evaluating data and making informed choices in vehicle selection. • Gain experience in designing user-centered tools that respond to specific needs, improving UI and UX design skills.	• User-friendliness: Intuitive interface for non-technical users. • Real-time updates: Reflect changes in technology trends and innovations. • Visualization: Clear graphical representation of features. • Interactivity: Allow users to simulate and compare options. • Accessibility: Map underserved regions with	Developing advanced Battery Management System (BMS TASK: Create predictive models that analyze degradation patterns over time based on real-world driving conditions, charging habits, temperature variations, and battery state-of-health (SOH) data. 3. Research solid-state battery technology, focusing on improving energy density, safety, and cycle life. Scenario: Solid-state batteries have the potential to offer significantly higher energy density and improved safety compared to traditional lithium-ion batteries. However, to meet automotive industry

in improving battery recycling efficiency and learn how policies can support research and development in this area. • Collaboration and Communication Skills: Develop collaborative and communication skills by presenting analysis and recommendations that consider diverse stakeholder perspectives, including government, industry, and consumers.		precision. • Optimization: Consider costs, demand, and grid infrastructure. • Scalability: Expandable network design for future growth. • User convenience: Easy integration with vehicle navigation systems. • Comprehensiveness: Cover economic, technical, and social factors. • Actionability: Provide clear recommendations based on findings. • Measurability: Quantify impacts (e.g., cost reduction, emission decrease). • Stakeholder relevance: Address needs of manufacturers, regulators, and consumers. • Accuracy: Reflect real-world implications of policies. • Scenario modeling: Evaluate varying levels of incentives or restrictions.	requirements, these batteries must achieve substantial improvements in energy density, safety, and cycle life to ensure cost-effectiveness and longevity in EV applications. Task: Experiment with high-capacity cathode materials that pair well with solid electrolytes, focusing on materials with high voltage potential to increase the overall energy density of the battery. 4. Explore the potential of second-life battery applications, such as stationary energy storage. Scenario: These batteries, often referred to as "second-life batteries," represent a valuable resource for stationary energy

			storage applications. By repurposing these batteries for grid-scale energy storage or residential energy storage systems, it is possible to extend the life of the batteries, reduce waste, and provide an affordable solution for integrating renewable energy sources like solar and wind. Task: Develop testing protocols to assess the remaining capacity, state-of-health (SOH), and performance of second-life batteries. This includes evaluating factors such as voltage retention, cycle life, and degradation rate. 1. Create an interactive dashboard to

			showcase new EV technologies like solid-state batteries and fuel cells. Scenario: a product manager for a leading automotive company, and you want to showcase the latest EV technologies to potential investors, partners, and internal stakeholders. TASK: Compare the performance of solid-state batteries and fuel cells to traditional lithium-ion batteries. 2. Develop a map-based application to identify and plan charging station networks in underserved areas. Scenario: An energy infrastructure planner working to expand the electric vehicle (EV) charging infrastructure in a specific region. Your goal is to

			identify areas with limited charging station access and develop a strategic plan for deploying new charging stations. TASK: Design a network of charging stations that covers the region efficiently and minimizes charging times for EV users. 3. Build a framework to evaluate challenges In EV sector Scenario: The electric vehicle (EV) industry faces numerous challenges, including technological limitations, infrastructure gaps, high initial costs, regulatory hurdles, and consumer adoption barriers. A systematic framework to evaluate these challenges can help policymakers, industry stakeholders, and

			researchers prioritize issues and devise effective solutions. This framework can also assist in tracking progress and addressing emerging challenges as the sector evolves. TASK: Identify and categorize key challenges in the EV sector. 4.Design a model to assess the impact of regulatory frameworks on EV adoption, such as subsidies, emission norms, and tax benefits. Scenario: Government policies and regulatory frameworks play a crucial role in driving the adoption of electric vehicles (EVs). Measures such as subsidies, emission norms, tax incentives, and infrastructure investments significantly

			influence consumer behavior and market dynamics. However, assessing the impact of these policies requires a systematic appr A well-designed model can help policymakers and industry stakeholders understand the direct and indirect effects of regulatory interventions. TASK: Use historical data and case studies from different regions.

TABLE 4: LIST OF FINAL PROJECTS (20 PROJECTS THAT COMPREHENSIVELY COVER ALL THE LEARNING OUTCOME)	
SL.NO	**FINAL PROJECT**
1	Electric Motor Optimization in EVs
2	AC Induction Motor in High-Performance EV
3	Battery Chemistry Development by EV Manufacturers
4	Battery Management in EVs
5	Thermal Management Systems for EVs
6	Torque and Speed Control with Motor Controllers
7	Real-time Battery Monitoring with BMS
8	Adaptive Energy Management in Hybrid EVs
9	Drive Mode Optimization in EVs
10	EV Powertrain Packaging and Layout
11	Lightweight Materials in EV Construction
12	HVAC Systems Integration in EVs

13	Autonomous EV Powertrain Integration
14	Develop advanced BMS algorithms to optimize battery performance and extend lifespan.
15	Research solid-state battery technology, focusing on improving energy density, safety, and cycle life.
16	Explore the potential of second-life battery applications, such as stationary energy storage.
17	Create an interactive dashboard to showcase new EV technologies like solid-state batteries and fuel cells.
18	Develop a map-based application to identify and plan charging station networks in underserved areas.
19	Build a framework to evaluate challenges (e.g., cost, range anxiety) and opportunities
20	Design a model to assess the impact of regulatory frameworks on EV adoption, such as subsidies, emission norms, and tax benefits

ANNEXURE III

COURSE ASSESSMENT RUBRICS (TOTAL MARKS: 70)				
ASSESSMENT CRITERIA	**DESCRIBE THE CRITERIA OF THE BELOW CATEGORY PERFORMANCE**			**TOTAL MARKS**
	FAIR	**GOOD**	**EXCELLENT**	
Knowledge and understanding	Recalls key definitions and concepts.	Explains concepts in a clear and concise manner.	Applies concepts to solve problems and answer questions in a comprehensive and insightful manner.	20
Application and Analysis	Attempts to apply knowledge to solve problems, even if the solution is not entirely accurate.	Applies knowledge to solve problems correctly, demonstrating a clear understanding of the concepts involved.	Critically analyzes problems, identifies relevant concepts, and applies knowledge to develop creative and effective solutions.	25
Evaluation and Synthesis	Identifies relevant information from various sources.	Analyzes and critiques information from various sources, identifying strengths and weaknesses.	Synthesizes information from various sources to form well-founded arguments and evidence-based conclusions.	15
Communication Skills	Presents information in a clear and organized manner, but may lack detail or clarity.	Presents information in a clear, concise, and well-organized manner, using appropriate language and terminology.	Presents information in a clear, concise, and well-organized manner, using sophisticated language and terminology to engage the audience.	10

Category	Assessment Criteria	Performance Levels	Weightage (Marks)
Practical Skills Proficiency	Demonstrates ability to perform job-specific tasks effectively, using relevant tools, techniques, or methodologies	Good, Fair, Excellent	20
Technical Knowledge Application	Applies theoretical concepts to practical scenarios with accuracy and relevance	Fair, Good,	15
Project Execution	Completes assigned projects or use cases demonstrating innovation, thoroughness, and skill application relevant to industry standards.	Fair, Good, Excellent	30
Communication and Reporting	Clearly presents findings, solutions, or project outcomes using professional communication and documentation standards (e.g., reports, presentations).	Fair, Good, Excellent	10

Level	Description
Fair (50%-64%)	Recalls basic definitions and concepts but struggles with application. Attempts to apply knowledge but often makes mistakes or lacks depth in analysis. Identifies some relevant information but struggles to analyze and synthesize it effectively. Presents information in a basic manner, lacking clarity and organization.
Good (65%-79%)	Explains concepts clearly and concisely, demonstrating a solid understanding. Applies knowledge to solve problems correctly,but may lack critical thinking and innovative solutions. Analyzes information effectively and identifies key points. Presents information clearly and concisely, using appropriate language and terminology.
Excellent (80%-100%)	Applies concepts to solve complex problems creatively and insightfully. Critically analyzes information, identifies underlying assumptions, and develops innovative solutions. Synthesizes information from multiple sources to form well-founded arguments and evidence-based conclusions. Presents information in a clear, concise, and engaging manner, using sophisticated language and terminology.