GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering Syllabus

Subject Code : 3726406

Subject Name : Testing and Certification of Electric Vehicles

WEF Academic Year :	2023 - 24
Semester :	2
Category of the Course :	Program Elective

Prerequisite :	A bachelor's degree in electrical engineering, mechanical engineering, or a related field. Basic knowledge of electric vehicles and energy storage systems.
Rationale :	This course focuses on the testing and certification processes for electric and hybrid vehicles, including safety, performance, and regulatory compliance. Students will learn about various testing methods, standards, and certification procedures to ensure the safe and reliable operation of electric and hybrid vehicles in different global markets.

Course Scheme :

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
3	0	2	4	70	30	20	30	150

Course Content :

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Power Train Testing :** Construction and functional safety requirements for L, M and N Categories of Electric power train vehicles (AIS-38), Measurement of Electrical Energy Consumption (AIS-39), Methods of measuring range (AIS 40), Measurement of Net power and maximum 30 min power (AIS-41). Central motor vehicle Rules-Type Approval for electric power train Vehicles: Tests for braking system, Gradeability, Measurement of pass by noise, lightning system (AIS-49), Electric Vehicle conductive charging system (IEC 61851), Electrical safety testing (ISO 17409, ISO 6469-3), Interoperability and conformance testing (ISO 15118), EMC testing (IEC 61851-21-2), Functional safety testing (ISO 26262), Development testing, Validation testing, Environmental testing (ISO 16750, ISO 19453)	8	18

2	**Vehicle Safety Testing & Performance Testing** Crash testing and safety regulations, Battery safety and fire prevention, Onboard diagnostics (OBD) and fault tolerance, Safety, and performance standards, Acceleration and braking performance, Handling and stability testing, Range and energy consumption testing, Thermal management and cooling system testing, Introduction to ISO 26262, ASIL standards, Principle of Safety Test, Sampling of Testing, Classification of Safety, Exposure & Controllability, Testing of the Gadgets – horns, mirror, steering, tyres, brakes, airbags & glasses. Interfacing of Gadgets with the software, Software testing with controllability levels, Accelerator Control System, Motor power, Safety Requirements of Traction Batteries	8	18
3	**Battery and Energy Storage System Testing** Battery performance testing, Charging and discharging testing, Life-Cycle life testing, Environmental testing (temperature, humidity) battery parameters – SoC, DoD, SoH, etc. Constant Current Discharge Test Series, Peak Power Test, Constant Power Discharge Test, Variable Power Discharge Testing, Special Performance Tests, Partial Discharge Test, Stand Test, Sustained Hill-Climbing Power Test, Charge Optimization Testing, Fast Charge Test, Life Cycle Testing, Electrical safety (ISO 18243, EN 50604, IEC 62660), Performance testing (ISO 12405, ISO 18243, ISO 15118, IEC 62660), Homologation testing (R100, UN 38.3, R10), Functional safety (ISO 26262), Traction Batteries used for battery operated vehicles of L, M and N category. Protection against short circuit and overcharging of batteries, behaviour of battery pack in the face of mechanical test such as vibration test, shock test, overheating, water effects pointed steel rod penetration test to rule out fire/explosion events (AIS-48, 38), Methods of recycling of batteries.	8	18
4	**Emissions and Environmental Testing** Emissions testing and standards, Noise and vibration testing, Environmental impact assessments, Environmental testing (ISO 16750, ISO 19453), EMI-EMC levels (CI, BCI, RE,RI and CTE), measurement of EMI-EMC in/outside vehicle, communication with the gadgets and their tests as per ISO 26262, Life cycle analysis of electric vehicles	4	10

5	**Charging Station and Motor Testing** Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles. (IEC 62196 Part 1,2 and 3.), Specifications of a DC Quick Charger for Use with Electric Vehicles (IEEE 2030.1.1), Communication Between Plug-In Vehicles and Off-Board DC Chargers (SAE J2847) The Hipot Test for Dielectric Strength, Surge Test, Insulation resistance Test, Voltage Drop Test, The Core Loss Test, Continuity Tests, Power Supply Test , Running Amps Test, Insulation Resistance Test, AC Motor Winding Continuity Test	6	14
6	**Regulatory Compliance and Type Approval** Type approval processes, Regulatory authorities and agencies, Certification documentation and procedures, Comparative analysis of global regulations, Gujarat State Electric Vehicle Policy 2021, Central policy on infrastructure, for charging station of Electric Vehicles, Faster Adoption and Manufacturing of Electric vehicles in India (FAME), zero emission vehicles (ZEVs): towards a policy framework- NITI Ayog report, Bharat EV Charger specifications, Global Technical Regulation on Electric, Vehicle Safety (EVS)-20, GSR 709 (E), E Rickshaw & E cart, GSR 2590.	4	10
7	**Case Studies and Industry Best Practices** Real-world case studies of electric vehicle certification, Industry best practices in testing and certification, Testing labs and equipment for electric and hybrid vehicles, Emerging trends in certification and testing, Capstone project involving the development of a certification plan for an electric or hybrid vehicle, Final written report and presentation.	4	10
	Total	**42**	**100**

Reference Book :

1. Various Government Policy document available in open domain as mentioned in Section 1
2. Automotive Industries Standards, India
3. IEC, IEEE, ISO, SAE standards

Suggested Specification table with Marks (Theory) : (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**0**	**15**	**15**	**50**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

1. **Remembering:** Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
2. **Understanding:** Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
3. **Applying:** Carrying out or using a procedure for executing or implementing.
4. **Analyzing:** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.
5. **Evaluating:** Making judgments based on criteria and standards through checking and critiquing.
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

Note : This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books/Material :

1. Various Government Policy document available in open domain as mentioned in Section 1.
2. Automotive Industries Standards, India.
3. IEC, IEEE, ISO, SAE standards.

Course Outcomes :
At the end of the course, student should be able to:

Sr. No.	CO statement	Topics Mapped	Marks % weightage
CO-1	Analyze the testing requirements of battery management system in Electric vehicles.	1	20%
CO-2	Test the Power train, Motors & charging stations & Mechanical aspects of Elective vehicles.	2,3,4,6	50%
CO-3	Apply the knowledge for Hybrid vehicles & Retrofitting of EVs.	5	15%
CO-4	Remember Government Policies for Electric Vehicles.	7	15%

Laboratory/Practical Work : Simulations using tools like MATLAB may be done to obtain performance parameters.

List of experiments :

1. To study battery parameters required for the Electric Vehicle and measure them.
2. To test the battery for its SoC, DoD, SoH for different Life-cycle and temperature.
3. To study the speed characteristics of BLDC for Electric Vehicle in SHEV, PHEV & CHEV configuration.
4. To design the power train for the two wheeler vehicle.
5. To design the power train for the three wheeler vehicle.
6. To design the power train for the four wheeler vehicle.
7. To study the temperature characteristics of the materials used in Electric Vehicle.
8. To measure the optimum Storage System for the Vehicle with/out regenerative braking.
9. To test the time/current/SoC using the fast & slow charging method.
10. To study the standards for the motor testing of EVs.
11. To study the standards for the Charging stations of the EVs.
12. To study the standards for the utility system of the EVs.
13. To study the government policy for the EVs.
14. To survey the implementation of the government policy for 2W, 3W & 4W.
15. To analyse a case study of the EV charging in cities.
16. To visit the testing centre of the Vehicle. (ex. ARAI-Pune).
17. To study and measure the hazards of the EMI-EMC inside/outside Electric Vehicle.

Online Available Resources :

1. https://morth.nic.in/ais
2. https://www.iso.org/standard
3. https://www.sae.org/standards/content/j2847/2_201504/
4. https://standards.ieee.org/standard
5. https://webstore.iec.ch/publication/6582
6. https://www.araiindia.com/services/department-and-laboratories/materials
7. https://facilities.mcmaster.ca/building/mcmaster-automotive-research-centre-marc

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