GUJARAT TECHNOLOGICAL UNIVERSITY

BE - Semester 6
Minor Degree : Electrical Vehicles
Subject Code : 116AL02
Subject Name : Testing and Certification of Electrical and Hybrid Vehicles

Type of course : (Electric Vehicle Category)

Prerequisite : Electrical Machines, Fundamentals of EV.

Rationale : Electric vehicles are available in various configurations ranging from Two wheelers to buses as well**.** The widespread utilization of Electric vehicles in all the segments of transportation have made it mandatory to standardize them and test them. The subject introduces to the major standards available in India as well as globally. Major tests on Electric and Hybrid vehicles have also been introduced. After learning this course, the students should be able to test the EVs effectively.

Teaching and Examination Scheme :

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	100
3	0	2	4	70	00	30	00	

Sr. No.	Content	Total Hrs.	Weightage
1	**Battery testing :** Introduction to Batteries, Classification of Batteries, Application of Batteries (load characteristics of it), Battery parameters – SoC, DoD, SoH, Life-cycle, 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.	9	20 %
2	**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),	9	20 %

	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).		
3	**Charing Station Requirements :** 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).	6	15 %
4	**Motor Testing :** 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.	4	10 %
5	**Vehicle Functional Safety Test :** 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, 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, Testing as per AIS 138 Part 1 and Part 2 Testing as per Bharat EV Charger Specifications AC001 and DC001.	9	20 %
6	**Policies :** 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.	5	15 %

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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. **Analysing :** 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	Analyse 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