GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Electric Vehicle Technology)

Subject Code : 3726413

Subject Name : EV Charging

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

Objective:

The main objective is to understand the fundamental concepts related to charging of the electric vehicle battery and related study. This course includes practical aspects various systems, strategies and challenges for the EV charging.

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)	
3	0	2	4	70	30	30	20	150

Sr. No.	Content	Total Hrs.
1	**Overview:** Review of battery and battery charging, Charger types; AC charging - Type 1,2,3 ; DC charging - CHAdeMO, Tesla, CCS, GB/T; Fast charging and its limitations; Vehicle to grid (V2G) technology, Role of EV charging in the transition to sustainable transportation, Analysis of EV charger components and functionalities, Charging protocols (OCPP), CAN and FDCAN for DC chargers and standards, requirements in India :AIS-138(part1) AIS-138(part2), ARAI certification.	**8**
2	**Battery Charging Methods:** Constant current charging, Constant voltage charging, trickle charging, boost charger CC/CV, Multistage current charging, comparison of charging methods, Bidirectional Charging Technologies	**6**
3.	**On Board Chargers for EV:** Working, role, types, reducing the dimensions and weight of the charger with an emphasis on high energy density, high charging efficiency and good heat dissipation, conductive charging and Wireless charging, Principle, types - Static charging, Dynamic charging Advantages and disadvantages of wireless charging	**6**
4	**Power Converters for Battery Chargers:** various typologies, single phase PFC BOOST and Three phase Vienna rectifier, LLC half bridge, CLLC full bridge, PSFB and DAB, design of power converters based on technical documents like data sheets, application notes, design note etc. from various semiconductor manufacturers.	**16**
5	**Hardware and Software Challenges in EV Charging:** Technical challenges in hardware design, Software considerations and advancements, temperature, efficiency improvement.	**4**
6	**Safety, Reliability, and Maintenance of Charging Systems:** Safety standards and protocols, Reliability engineering and maintenance practices	**4**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	25	30	15	5	5

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

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 the above table.

Reference Books:

1. H. Sjafrie, "Introduction to Self-Driving Vehicle Technology", Chapman & Hall/CRC Artificial Intelligence and Robotics Series, ISBN-10 0367321254, ISBN-13 978-0367321253, Dec 2019.
2. AIS-138 part1, AIS-138 part2
3. Texas Instrument Reference Design : TIDA-00637 Level1 and level2 electric vehicle service equipment(EVSE) reference design- (www.ti.com)
4. Texas Instrument SAE J1772 compliant EVSE reference design – TIDA-010071
5. Texas Instruments Design Guide: TIDA-010239 AC Level 2 Charger Platform Reference Design
6. Texas Instruments Design Guide: TIDM-02013 7.4-kW EV or HEV Bidirectional On board Charger Reference Design With GaN
7. Texas Instruments Technical Article: Top 3 Design Considerations for EV Charging
8. Texas Instruments Application Report: Power Topology Considerations for Electric Vehicle Charging Stations
9. Texas Instruments Reference Design: Wi-Fi Enabled Level 1 and Level 2 Electric Vehicle Service Equipment Reference Design (www.ti.com)
10. ST Application Note AN 5949 SR5E1 line - 7 KW EV/HEV on-board-charger reference design.
11. ST Document UM2940 Getting started with the STDES-7KWOBC 7 kW on-board charger reference.
12. Infineon Technologies: UG-2020-31 11 kW bi-directional CLLC DC-DC converter

Course Outcomes:

S. No	CO STATEMENT	Bloom's taxonomy level	Marks % weightage
CO1	Explain basic principles and battery charging methods with reference to EV.	Remember L1, Understand L2	**20**
CO2	Explain the working, role, and types of on board chargers for EV.	Remember L1 , Understand L2	**25**
CO3	Design power converters for battery chargers	Remember L1 Analyze L4, Create L6	**35**
CO4	Determine technical challenges in hardware and software design for EV.	Understand L2, Evaluate L5	**20**

Suggestive List of Experiments:

1. Study of battery chargers
2. Study of various charging protocols
3. Study of wired chargers
4. Study of wireless chargers
5. Study of power converters for battery charging systems
6. Study of safety standards for battery chargers for EV.

   In addition to above suggested experiments, a small hardware / software design and testing project can be assigned to students having weightage of 4 – 6 experiments.

List of Software/learning website:

1. www.ti.com
2. www.st.com
3. www.infineon.com.
4. araiindia.com
5. https://in.mathworks.com/discovery/adas.html
6. https://dewesoft.com/blog/types-of-adas-sensors
7. https://www.analytixlabs.co.in/blog/fundamentals-of-neural-networks/
8. https://in.mathworks.com/videos/getting-started-with-neural-networks-using-matlab-1591081815576.html
9. https://in.mathworks.com/discovery/neural-network.html
10. https://in.mathworks.com/help/fuzzy/fuzzylogicdesigner-app.html

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