GUJARAT TECHNOLOGICAL UNIVERSITY
Program Name: Engineering
Level: PG
Branch: Electric Vehicle Technology
Course / Subject Code: ME01064071
Subject Name: Charging Strategies & Infrastructure for Electric Vehicles

WEF Academic Year :	2024 – 25
Semester :	1st Semester
Category of the Course :	PEC

Prerequisite:	Nil
Objective:	The objective of the course is to learn the charging strategies for Electric vehicles and its impact on the grid. The course also deals with the infrastructural requirements norms and standards in relation tothe charging stations.

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	30	20	150

Course Content :

Sr No	Content	Total Hrs.
1	**INTRODUCTION :** Principles of operation of cells and batteries, Electrochemical principles and reactions, Types of batteries, Fuel cells, Supercapacitors, Selection and application of energy storage systems for electric vehicle system, Brief introduction to Lead-acid, Ni-based, Lithium-Ion and Sodium-Ion batteries, Battery performance parameters, Battery sizing.	07
2	**BATTERY MANAGEMENT SYSTEM :** Selection of battery for EV, Traction battery pack design, Requirement of battery monitoring, Battery state of charge estimation methods, Battery cell equalization problem and solution, Protection interface, Energy and power estimation, Battery thermal management system, Components of battery management system, Battery packsafety, Battery standards & tests.	10

3	**SMART CHARGING OF ELECTRIC VEHICLES :** Charger types and description of charging technologies, Connectors, Relevant standards, Communication protocols, Smart Control functionalities, Commercially available EVchargers, Wireless charging of batteries, Commercially available smart charging technologies and products, Smart EV charging projects National and International.	**09**
4	**EV CHARGING STRETEGIES BASED ON CONTROL ARCHITECTURE :** Centralized control, Decentralized control, Distributed control, Hierarchical control, Local control, Smart charging based on optimization algorithms, AI/Machine learning based charging strategy	**09**
5.	**INFRASTRUCTURE FOR EV CHARGING :** Principles for location planning of EV charging stations, Geospatial analysis and locations, Land allocation, Off-grid charging with renewable sources. Improving the utilization of the grid with V2G concept, Grid planning with EV charging stations, Metering or pricing with commercial charging, Regulatory framework for charging stations, Roles of DISCOMs, Safety provisions for the EV charging stations, Battery swapping concept a critical overview, Grid integration and stability issues with Vehicle to Grid, Harmonic and power quality issues associated with high power commercial charging.	**10**
	TOTAL	**45**

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: Application, 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. NITI Aayog report on "Smart charging strategies and technologies for Electric Vehicles" Zakir
   Rather, Payal Dahiwale, Dhanuja Lekshmi and others
2. NITI Aayog handbook on "Electric Vehicle Charging Infrastructure Implementation Version-1"
   Amitabh Kant, Randheer Singh, Sanjeev Kumar Kassi and others
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, John Wiley & Sons.
4. Sandeep Dharmeja, Electric Vehicle Battery Systems, Newnes.
5. Shichun Yang, Xinhau Liu, Shen Li, Cheng Zhang, Advanced Battery Management System for Electric Vehicles, Springer
6. Chung Chow Chan, K. T. Chau, Modern Electric Vehicle Technology, Oxford University Press.

7. Qiuwei Wu, Grid Integration of Electric Vehicles in Open Electricity Markets, John Wiley & Sons, Ltd.

Course Outcomes :

S. No.	CO STATEMENT	Bloom's taxonomy level	Marks % weightage
CO1	To learn the battery construction, performance analysis and Battery management system.	Remember L1 , Understand L2, Application L3, Evaluate L5	**20%**
CO2	To analyze the Smart charging strategies for Electric Vehicles.	Remember L1 , Understand L2, Analyze L4, Evaluate L5	**30%**
CO3	To understand the control architecture and algorithms for smart charging.	Remember L1 , Understand L2, Evaluate L5	**20%**
CO4	To evaluate the infrastructure requirements for EV charging.	Remember L1 , Understand L2, Evaluate L5, Create L6	**30%**

- Simulation and analysis of constant current/constant voltage charging technique.
- Simulation and analysis of trickle charging technique.
- Study/online demonstration of battery management system.
- Simulation and analysis of on-board charger.
- Simulation and analysis of vehicle to grid interfacing.
- Simulation of fast dc charging system
- Programming for optimum location planning for EV charging stations
- Study of the safety norms for the EV charging stations
- Simulation to analyse the power quality issues with EV charging

➢ Visit to EV manufacturing unit or EV charging and Maintenance unit is suggested

List of Software/learning website :

- MATLAB

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