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यंत्र अभियांत्रीक विभाग
शासकिय अभियांत्रिकी महाविद्यालय, कराड
दिनांक- 11/06/2025

Government College of Engineering, Karad

Third Year (Sem – V) B. Tech. Mechanical Engineering

IMI 3533: EV Charging Infrastructure & Guidelines

Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite :
Basics of Electrical & Electronics Engineering, Fundamentals of Electric & Hybrid Vehicle Technology, Batteries, Powertrain &Transmission

Course Outcomes (CO): Students will be able to

CO1	Analyse the current EV market trends, growth projections, and opportunities in charging infrastructure
CO2	Design and test EV charging infrastructures, considering site selection, layout planning, electrical and civil engineering aspects, and performance testing protocols through practical design exercises.
CO3	Apply international and national regulatory guidelines and safety standards in the installation, maintenance, and operation of charging stations, focusing on compliance, safety, and environmental regulations through case studies.
CO4	Evaluate the latest advancements in charging technologies and standards, including high-power charging, bi-directional V2G technology, and smart charging systems, using simulation exercises to model advanced charging systems.

	Course Contents	**CO**	**Hours**
Unit 1	**EV Market Insights and Opportunities** EV Market Overview-Current market trends and growth projections-Key players and stakeholders in the EV market-Opportunities in Charging Infrastructure - Public vs. private charging infrastructure - Government Policies and Incentives - Impact of policies on market growth - Case Studies	**CO1**	**(03)**
Unit 2	**Design and Testing of Charging Infrastructures** Charging Infrastructure Design Principles - Site selection and layout planning - Electrical and civil engineering considerations - Types of Charging Stations - Level 1, Level 2, and DC fast charging - Testing and Validation - Performance testing of charging stations - Reliability and safety testing protocols - Practical Design Exercises.	**CO2**	**(09)**
Unit 3	**Regulatory Guidelines and Safety Standards** International and National Standards - Overview of key standards (IEC, ISO, SAE), Compliance requirements for different regions - Installation and Maintenance Regulations - Permitting and inspection processes, Maintenance protocols and safety checks - Environmental Regulations - Impact of charging infrastructure on the environment, Sustainable practices in design and operation - Case Studies	**CO3**	**(06)**
Unit 4	**Latest Charging Technologies and Standards** Advancements in Charging Technology - High-power charging solutions, Bi-directional charging and vehicle-to-grid (V2G) technology - Connector types and interoperability, Communication protocols (OCPP, ISO 15118) - Smart Charging Systems - Emerging Technologies, Inductive and dynamic wireless charging, Ultra-fast charging technologies - Practical Simulation Exercises - Simulation of advanced charging systems using industry-standard software.	**CO4**	**(06)**
Unit 5	**Management of Charging Networks** Charging Network Management - Predictive maintenance and performance optimization - Customer Experience and User Interface	**CO3** **CO4**	**(06)**
Unit 6	**Economic of Charging Networks** Economic and Financial Considerations - Cost analysis and ROI calculations, Pricing models and revenue streams - Case Studies - Successful management of large-scale charging networks, Lessons from leading network operators	**CO3** **CO4**	**(08)**

Text Books

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1	Electric Vehicle Technology Explained" by James Larminie and John Lowry
2	"Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain
3	"Electric Vehicle Systems Architecture and Standardization Needs" by Muhammad Ehsani, Mehrdad Ehsani, and Ali Emadi
4	"Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids" by Jia- Sheng Zhang and David Xu
5	"Advanced Electric Drive Vehicles" edited by Ali Emadi
Reference Books	
1.	M. S. Alam, R. K. Pillai, and N. Murugesan, Developing Charging Infrastructure and Technologies for Electric Vehicles. IGI Global, 2021: ISBN-13: 9781799868590: ISBN- 10: 1799868591
2	Vahid Vahidinasab and Behnam Mohammadi-Ivatloo, Electric Vehicle Integration via Smart Charging. Springer Nature, 2022.ISBN-13: 9783031059087: ISBN-10: 3031059085
3	Sivaraman Palanisamy, Sharmeela Chenniappan, and Sanjeevikumar Padmanaban, Fast-Charging Infrastructure for Electric and Hybrid Electric Vehicles. John Wiley & Sons, 2023. ISBN-13: 9781119987741: ISBN-10: 1119987741
4	Sulabh Sachan, Sanjeevikumar Padmanaban, and S. Deb, Smart Charging Solutions forHybrid and Electric Vehicles. John Wiley & Sons, 2022. ISBN-13: 9781119768951: ISBN-10: 1119768950
5	R. Wang, P. Wang, and G. Xiao, Intelligent Microgrid Management and EV Control UnderUncertainties in Smart Grid. Springer, 2017. ISBN-13: 9789811350870: ISBN-10: 9811350876
	Useful link
	"Introduction to Electric Vehicles" - offered by Indian Institute of Technology Delhi on NPTEL Link: https://onlinecourses.nptel.ac.in/noc21_ee05/preview

Mapping of COs and POs

PO →	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 6	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	-	-	-	-	-	-	-	-	2	2	3
CO 2	3	3	3	1	2	1	-	-	1	-	1	1	3	3
CO 3	3	2	3	-	2	-	-	-	1	-	-	2	3	2
CO 4	3	3	1	-	3	-	-	-	-	-	-	2	2	3

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	5	5	10
Understand	-	-	-
Apply	5	5	10
Analyse	5	5	20
Evaluate	5	5	20
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad				
Third Year (Sem –V) MDM- Electrical Vehicle (Mechanical Engineering- Institute Level)				
IMI3534: Electric Vehicle Lab				
Laboratory Scheme:			**Examination Scheme:**	
Practical	2 Hrs/week		**ISE**	50
Total Credits	1		**ESE**	--
			TOTAL: 50	

Prerequisite : Basics of Electronics	
Course Outcomes (CO): Students will be able to	
CO1	Perform experiments by interfacing sensor with microcontroller
CO2	Illustrate the MATLAB programming for EV systems
CO3	Develop and execute the Simulink model for different EV units
CO4	Design the power supply EV unit on PCB

Course Contents		CO
Experiment 1	Introduction to booting process of raspberry pi	**CO1**
Experiment 2	Perform experiment to control the speed of dc motor	**CO1**
Experiment 3	Interface IR/ PIR sensor with microcontroller	**CO1**
Experiment 4	Interface ultrasonic sensor with microcontroller and find distance	**CO1**
Experiment 5	Developing SIMULINK Models for Vehicle Units	**CO3**
Experiment 6	Programming EV Systems in MATLAB	**CO2**
Experiment 7	Application of Data Analysis Techniques in EV Electrical system	**CO2**
Experiment 8	Design a power supply unit and create a PCB design for same.	**CO4**
Experiment 9	Modelling and simulation of EV powertrain components in MATLAB	**CO3**
Experiment 10	Analysis of EV powertrain components in MATLAB	**CO3**
Experiment 11	Battery Management System modelling	**CO3**
Experiment 12	Modelling of Li-ion battery pack using MATLAB	**CO3**
List of Submission:		
Minimum number of Experiments: 10		

Mapping of COs and POs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	1	2	3	1	3	-	1	-	2	-	2	-	2	2
CO2	1	2	3	2	3	-	1	-	2	-	2	1	-	2
CO3	1	2	3	3	3	-	1	-	2	-	2	2	-	1
CO4	1	2	3	3	3	-	1	-	2	-	2	2	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Patten

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Avg
Task I	15	15	15	15	15	15	15	15	15
Task II	5	5	5	5	5	5	5	5	5
Task III	5	5	5	5	5	5	5	5	5
ISE	25	25	25	25	25	25	25	25	25

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Government College of Engineering, Karad				
Third Year (Sem – VI) B. Tech. Mechanical Engineering				
IMI 3635: Multiphysics based product development for BEV and FCEV				
Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Fundamentals of Mechanical Engineering Fundamentals of Electric and Hybrid Vehicle Technology

Course Outcomes (CO): Students will be able to

CO1	Utilize Finite Element Analysis (FEA) and Computer-Aided Engineering (CAE) tools to design and optimize electric and fuel cell vehicles
CO2	Develop advanced structural models for vehicle components And Conduct dynamic simulations to evaluate vehicle crashworthiness, safety, fatigue, and durability, using practical exercises to predict and optimize vehicle performance under dynamic conditions
CO3	Apply Computational Fluid Dynamics (CFD) techniques to simulate and optimize vehicle aerodynamics and thermal management, as well as battery performance and thermal behaviour
CO4	Design and optimize thermal management systems and integrate hydrogen fuel cell technology in electric and fuel cell vehicles

	Course Contents	CO	Hours
Unit 1	**Finite Element Analysis (FEA) and Computer-Aided Engineering (CAE)** Introduction to FEA and CAE - Basics of Finite Element Analysis, Overview of Computer-Aided Engineering tools - Applications in BEV and FCEV - Use of FEA and CAE in electric and fuel cell vehicle design, Case studies highlighting successful applications - Software Tools - Introduction to industry-standard FEA and CAE software (e.g., ANSYS, Abaqus), Setting up and running simulations - Structural Analysis Techniques -Techniques for analyzing structural integrity and performance, Evaluating stress, strain, and deformation in vehicle components - Hands-On Simulation Exercises - Practical exercises using FEA and CAE software, Analyzing and interpreting simulation results - Case Studies Real-world examples of FEA and CAE in vehicle development, Lessons from industry applications	**CO1**	**(08)**
Unit 2	**Structural Analysis and Advanced Modeling** Advanced Structural Modeling - Detailed modeling of vehicle components and assemblies, Techniques for creating accurate and efficient models - Material Properties and Behavior - Understanding material properties and their impact on structural performance, Modeling complex material behaviors (e.g., composites, metals) - Dynamic Analysis -Techniques for dynamic analysis of vehicle structures, Evaluating the impact of dynamic loads and vibrations -Optimization Techniques - Structural optimization methods for weight reduction and performance improvement, Using optimization tools in CAE software - Simulation and Testing - Correlating simulation results with physical testing, Validation and verification of models - Case Studies - Examples of advanced structural modeling and analysis in BEV and FCEV development, Insights from successful projects	**CO2**	**(08)**
Unit 3	**Dynamic Simulation and Material Properties** Introduction to Dynamic Simulation - Basics of dynamic simulation and its importance in vehicle development, Tools and techniques for dynamic analysis - Material Properties in Dynamic Simulation - Importance of accurate material properties in dynamic simulations, Techniques for characterizing and modeling material behavior - Crashworthiness and Safety Analysis - Techniques for simulating vehicle crashworthiness and safety, Evaluating impact performance and occupant protection - Fatigue and Durability Analysis - Methods for assessing fatigue and durability of vehicle components, Predicting component life under cyclic loading - Hands-On Simulation Projects - Practical exercises in dynamic simulation, Analyzing and optimizing vehicle performance under dynamic conditions - Case Studies - Real-world applications of dynamic simulation in BEV and FCEV development, Lessons	**CO3**	**(08)**

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	from industry leaders		
Unit 4	**Computational Fluid Dynamics (CFD) and Battery Simulation** Introduction to CFD - Basics of Computational Fluid Dynamics and its applications in vehicle design, Overview of CFD software tools - Aerodynamic Analysis - Techniques for simulating and optimizing vehicle aerodynamics, Evaluating drag, lift, and airflow around vehicles - Thermal Management in CFD - Importance of thermal management in BEVs and FCEVs, Techniques for simulating heat transfer and thermal behavior - Battery Simulation - Modeling and simulating battery performance and thermal behavior, Evaluating battery life and efficiency under various conditions - Hands-On CFD Projects - Practical exercises using CFD software, Simulating aerodynamic and thermal performance of vehicles - Case Studies - Examples of successful CFD and battery simulation projects, Insights from industry applications	**CO4**	**(09)**
Unit 5	**Advanced Thermal Management and Hydrogen Fuel Cell Technology** Thermal Management Systems - Principles of thermal management in electric and fuel cell vehicles, Techniques for optimizing thermal systems for performance and reliability - Hydrogen Fuel Cell Technology - Basics of hydrogen fuel cells and their applications in vehicles, Integration of fuel cells with vehicle systems - Thermal Integration in FCEVs - Challenges and solutions for thermal integration in hydrogen fuel cell vehicles, Techniques for managing heat generated by fuel cells - Simulation of Thermal and Fuel Cell Systems - Tools and techniques for simulating thermal management and fuel cell performance, Practical exercises using simulation software - System-Level Integration - Integrating thermal management and fuel cell systems with other vehicle components, Ensuring optimal performance and efficiency - Case Studies - Real-world examples of thermal management and fuel cell integration in vehicles, Lessons from successful projects	**CO3** **CO4**	**(09)**

Text Books	
1	Electric Vehicle Technology Explained" by James Larminie and John Lowry
2	"Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain
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4	"Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids" by Jia- Sheng Zhang and David Xu
5	"Advanced Electric Drive Vehicles" edited by Ali Emadi
Reference Books	
1.	"Practical Finite Element Analysis" by Nitin S. Gokhale, Sanjay S. Deshpande, Sanjeev V. Bedekar, and Anand N. Thite
2	Engineering Analysis with ANSYS Software" by Tadeusz Stolarski, Y. Nakasone, and S. Yoshimoto
3	"Introduction to Finite Element Analysis and Design" by Nam-Ho Kim, Bhavani V. Sankar, and Ashok V. Kumar
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CO 2	3	-	-	1	2	1	-	-	1	-	1		2	2
CO 3	3	3	3	-		-	-	-	1	-	-	2	1	2
CO 4	3	3	1	-	3	-	-	-	-	-	-	2	2	3

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