List of Multi-disciplinary Minor (Institute Level-Industrial)

Stream/Technology	Sr.No.	Course category	Course code & Title	Semester
Electrical Vehicle (Electrical Engineering-Institute Level-Industrial)	1	Multi-disciplinary Minor - 01	IMI3311: Foundation of EV and Hybrid Vehicle	III
	2	Multi-disciplinary Minor – 02	IMI3412: EV Battery Technology and Powertrain Development	IV
	3	Multi-disciplinary Minor – 03	IMI3513: EV Power Electronics and Embedded System	V
	4	Multi-disciplinary Minor Lab – 03	IMI3514: Electric Vehicle Lab	V
	5	Multi-disciplinary Minor – 04	IMI3615: EV Charging Infrastructure, Vehicle Testing & Homologation	VI
	6	Multi-disciplinary Minor – 05	IMI3716: EV Vehicle Design, Analysis and Control	VII
	7	Multi-disciplinary Minor - 06	IMI3817: EV PCB Design & Data Analytics	VIII
Image Processing (ETC-Institute Level-Industrial)	1	Multi-disciplinary Minor - 01	IMI3321: Fundamentals of Image.	III
	2	Multi-disciplinary Minor – 02	IMI3422: Basics of Image Processing for Healthcare	IV
	3	Multi-disciplinary Minor – 03	IMI3523:Particle Size Analysis using Image Processing	V
	4	Multi-disciplinary Minor Lab – 03	IMI3524: Particle Size Analysis using Image Processing Lab	V
	5	Multi-disciplinary Minor – 04	IMI3625: Particle Characterization in Healthcare	VI
	6	Multi-disciplinary Minor – 05	IMI3726:Particle Characterization in Formulation and Reverse Engineering	VII
	7	Multi-disciplinary Minor - 06	IMI3827:Project	VIII
Electrical Vehicle (Mechanical Engineering-Institute Level-Industrial)	1	Multi-disciplinary Minor - 01	IMI3331:Foundation of EV and Hybrid Vehicle	III
	2	Multi-disciplinary Minor – 02	IMI3432:Automotive Mechanics for EV	IV
	3	Multi-disciplinary Minor – 03	IMI3533:EV Charging Infrastructure and Guidelines	V
	4	Multi-disciplinary Minor Lab – 03	IMI3534:Electric Vehicle Lab	V
	5	Multi-disciplinary Minor – 04	IMI3635:Multiphysics based product development for BEV and FCEV	VI
	6	Multi-disciplinary Minor – 05	IMI3736: Electrical Vehicle Dynamics	VII
	7	Multi-disciplinary Minor - 06	IMI3837: Systems Engineering Approach to EV Design	VIII

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Multi-Disciplinary Minor (MDM)

Course Syllabi

Electrical Vehicle

(Mechanical Engineering-

Institute Level-Industrial)

Government College of Engineering, Karad

Final Year (Sem – VII) B. Tech. Mechanical Engineering

IMI3736: Electric Vehicle Dynamics (Multi-Disciplinary Minor 05)

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	Explain the fundamental principles of vehicle and tire dynamics
CO2	Analyze the effects of chassis, steering, and braking systems on vehicle dynamics for performance improvement
CO3	Design and optimize vehicle stability control systems and aerodynamic performance for safety and energy efficiency
CO4	Simulate electric and hybrid vehicle dynamics with focus on powertrain and energy management

	Course Contents	**CO**	**Hours**
Unit 1	**Fundamentals of Vehicle and Tire Dynamics** Introduction to Vehicle Dynamics - Basic principles and concepts, Importance in overall vehicle performance - Tire Dynamics - Suspension Systems - Vehicle Load Transfer - Steering Mechanisms -Impact on Vehicle Dynamics-Influence of steering system design on handling characteristics-Steering response and feedback-Simulation and Modeling - Tools for simulating vehicle and tire dynamics - Case Studies - Analysis of real-world vehicle dynamics scenarios	**CO1**	**(07)**
Unit 2	**Vehicle Components and Mechanics** Chassis and Frame Design - Structural design considerations, Impact on vehicle dynamics and safety - Brake Systems - Dynamics of braking and brake force distribution, Advanced braking technologies (ABS, EBD) - Powertrain Layouts - Different powertrain configurations (FWD, RWD, AWD) - Systems engineering approach to vehicle design - Practical Exercises - Hands-on projects to analyze and improve vehicle mechanics	**CO2**	**(07)**
Unit 3	**Vehicle Stability Control Systems** Introduction to Vehicle Stability Control - Principles of stability control systems, Importance for safety and performance - Dynamic Stability Control Systems - Electronic Stability Control (ESC) and Traction Control Systems (TCS)	**CO3**	**(05)**
Unit 4	**Vehicle Aerodynamics and Performance Optimization** Fundamentals of Vehicle Aerodynamics, Basics of wind tunnel testing, Analyzing and optimizing aerodynamic performance - Case Studies - Examples of aerodynamic optimization in modern EVs, Lessons learned from industry leaders	**CO4**	**(05)**
Unit 5	**Dynamics of Electric and Hybrid Vehicles** Electric and Hybrid Powertrain Dynamics - Differences between ICE and electric/hybrid powertrains, Dynamics of electric motors and regenerative braking - Energy Management in EVs - Strategies for efficient energy use, Impact on vehicle dynamics and performance - Hybrid Vehicle Dynamics - Interaction of electric and ICE components, Control strategies for optimal performance - Thermal Management Systems - Practical exercises using advanced simulation tools - Case Studies - Analysis of successful electric and hybrid vehicle designs, Insights from industry applications	**CO3** **CO4**	**(08)**
Unit 6	**Handling, Ride Quality, and Stability Analysis** Handling Characteristics of EVs - Factors influencing vehicle handling, Techniques for improving handling performance - Ride Quality Analysis - Importance of ride comfort in EVs, Methods for evaluating and enhancing ride quality - Vehicle Stability Analysis - Techniques for assessing vehicle stability - Tools and techniques for dynamic optimization, Practical exercises in vehicle dynamics optimization - Case Studies - Real-world examples of handling, ride quality, and stability improvements.	**CO3** **CO4**	**(08)**

Text Books

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

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	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.	"Fundamentals of Vehicle Dynamics" by Thomas D. Gillespie
2	"Road Vehicle Dynamics: Fundamentals and Modeling with MATLAB" by Georg Rill and Abe Steiner
3	"The Multibody Systems Approach to Vehicle Dynamics" by Michael Blundell and Damian Harty
4	"Race Car Vehicle Dynamics" by William F. Milliken and Douglas L. Milliken
	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 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	2	–	–	2	–	–	–	–	–	1	2	2	3
CO 2	3	3	2	–	2	–	–	1	–	–	1	1	3	3
CO 3	2	2	3	2	3	1	–	1	1	–	1	2	3	2
CO 4	2	2	2	2	3	1	–	–	–	–	2	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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Final Year (Sem – VIII) B. Tech. Mechanical Engineering

IMI 3837: Systems Engineering Approach to EV Design (Multi-Disciplinary Minor 06)

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

Prerequisite :
Fundamentals of Electric and Hybrid Vehicle Technology, Batteries, Powertrain & Transmission for EVs

Course Outcomes (CO): Students will be able to

CO1	Design EV electrical systems including propulsion, batteries, power electronics, and BMS.
CO2	Develop thermal management systems for EV components using simulation tools
CO3	Apply mechanical design and system integration principles to ensure EV component reliability and performance
CO4	Model and analyze interactions among EV components using industry-standard simulation software for design optimization

	Course Contents	**CO**	**Hours**
Unit 1	**Battery Systems and Electric Motors for Electric Vehicles** Introduction to Battery Systems - Overview of battery systems in electric vehicles - Importance of batteries in EV performance and range - Mathematical Models of Battery Systems, Performance Analysis of Battery Systems - Battery performance metrics - Charge/discharge cycles, efficiency, and thermal behavior - - Modeling SOC and SOH estimation in MATLAB/Simulink - Introduction to Electric Motors - Types of electric motors used in EVs- DC motor models -Induction motor models - Losses in electric motors: Copper losses, iron losses, friction losses -	**CO1**	**(06)**
Unit 2	**Power Electronics and Energy Conversion in Electric Vehicles** Importance of power electronics in EVs: Inverters, converters, and their roles - Key components: IGBTs, MOSFETs, diodes - Mathematical Models of Power Electronics - Inverter models: Single phase and three-phase inverters - DC-DC converter models: Buck, Boost, Buck-Boost converters - Performance Analysis of Power Electronics - Efficiency analysis: Switching losses, conduction losses	**CO2**	**(05)**
Unit 3	**Component Selection and Sizing** Selection Criteria for EV Components - Criteria for selecting batteries, motors, inverters, and other components - Component Sizing Techniques - Sizing batteries based on energy and power requirements - Sizing motors based on vehicle performance requirements - Single Dimensional Longitudinal Analysis - Longitudinal dynamics: Forces acting on the vehicle - Equations of motion and their applications - Practical Simulation Examples - Battery sizing for a given driving cycle using MATLAB/Simulink - Motor sizing and performance analysis in MATLAB/Simulink	**CO3**	**(07)**
Unit 4	**Thermal and Electrical Considerations** Continuous and Peak Ratings of Components - Understanding continuous and peak power ratings of EV components - Temperature Considerations - Thermal management of EV components - Defining system-level requirements for EV design - Practical Simulation Examples - Thermal modeling of battery and motor systems in MATLAB/Simulink - Analyzing the impact of temperature on component performance	**CO4**	**(06)**
Unit 5	**System Engineering Approach to EV Design** Introduction to System Engineering for EVs - Principles of system engineering - Applying system engineering to EV design - Algorithms Used in EV Components - Battery Management System (BMS) algorithms - Motor controller algorithms - DC-DC converter control strategies - On-board charger control algorithms - Practical Simulation Examples - Implementing BMS algorithms in MATLAB/Simulink - Motor controller tuning and performance analysis - DC-DC converter control simulation	**CO3** **CO4**	**(08)**
Unit 6	**Advanced Topics in EV Dynamics** Controller Tuning and Optimization - Techniques for tuning motor controllers and other EV controllers - Optimization methods for improving system performance - Sequential Analysis of Vehicle-Level Scenarios - Case studies of vehicle dynamics under various conditions - System-Level Simulation and Validation - System-level simulation techniques	**CO3** **CO4**	**(08)**

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	- Practical Simulation Examples - Vehicle dynamics simulation for different driving cycles in MATLAB/Simulink - System-level performance validation using simulation tools		

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