

**Government College of Engineering, Karad**  
**Second Year (Sem – III) B. Tech. Mechanical Engineering**  
**IMI3331: Foundation of EV and Hybrid Vehicle**

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 :** Basics of mechanical, Basics of electrical

**Course Outcomes:**After completion of the course the student will be able to

CO1	Explain the fundamentals of EV technology
CO2	Identify and discuss different components and their operation need in a Hybrid vehicle
CO3	Demonstrate different battery technologies and charging stations
CO4	Calculate motors and motor controller sizing need in an EV

Course Contents		CO	Hours
<b>Unit 1</b>	Introduction to EV: Explaining EV technology and summarize Automotive revolution, explore Electrical Requirement of a vehicle,	CO1	(4)
<b>Unit 2</b>	EV layout and components: Exploring different types of EV layouts and basic components of Electric Vehicle	CO1	(4)
<b>Unit 3</b>	Introduction to Hybrid electric vehicle: Defining Hybrid Vehicle working principles and architecture. Introduction, Battery chemistry ,Efficiency ,Definition and parameters for Hybrid Systems	CO2	(4)
<b>Unit 4</b>	Layout and component of hybrid electric vehicle : Electric Motors ,Generators , and Power electronics for Hybrid systems, control systems, Hybrid electric vehicle operation	CO2	(4)
<b>Unit 5</b>	Identify and demonstrate Battery Technology and charging station infrastructure: Defining Battery Technology, recognize different types of batteries and components of Battery, describing EV charging Infrastructure	CO3	(4)
<b>Unit 6</b>	Advanced EV: Listing of Electrical Requirement needed in EV, state Power distribution specifications, describe Electronic control system, Listing of EV standards and classifications. Summarize criteria for selection of electrical and electronic components for EV. brief outline of Motors need in EV	CO4	(4)

**Reference Books**

1.	Julian Happian-Smith; Transport Research Laboratory (TRL) Introduction to Modern Vehicle Design, Publisher: Elsevier- edition 2001
2.	Heinz Heisler; Advanced Vehicle Technology, Publisher: Butterworth-Heinemann Ltd; 2nd edition- July 2002
3.	Seth Leitman, Bob Brant, Leitman Seth; Build Your Own Electric Vehicle: Publisher: McGraw-Hill - 3 <sup>rd</sup> edition-feb 2013

**Reference links**

1.	<a href="https://www.carbodydesign.com/">https://www.carbodydesign.com/</a>
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### Mapping of COs and POs:

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	-	-	3	-	2	-	-	2	-	3
CO 2	3	1	-	-	3	-	3	-	-	2	-	2
CO 3	3	2	2	3	3	-	3	-	2	2	-	3
CO 4	2	3	3	3	3	1	3	1	2	2	-	3

1: Slight(Low)

2: Moderate(Medium)

3: Substantial(High)

### Assessment Pattern(with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	4	4	10
Understand	4	4	10
Apply	4	4	10
Analyse	4	4	10
Evaluate	4	4	20
Create	-	-	-
TOTAL	20	20	60

**Government College of Engineering, Karad**  
**Second Year (Sem – IV) B. Tech. Mechanical Engineering**  
**IMI3432:Automotive Mechanics for EV**

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 :** Basics of mechanical, Basics of electrical, fundamentals of EV.

**Course Outcomes:** After completion of the course the student will be able to

CO1	Describe vehicle dynamics and elements involved in Automobile engineering
CO2	Demonstrate different automotive sketching techniques and various creative softwares
CO3	Design various systems of EV using advance modeling techniques and softwares
CO4	Analyze advance EV system using different data analysis software

Course Contents		CO	Hours
<b>Unit 1</b>	Introduction to vehicle dynamics Fundamentals of vehicle dynamics, different mechanisms and dynamics involved in wheels, fundamentals of Hybrid vehicle dynamics.	CO1	(4)
<b>Unit 2</b>	Aerodynamics and power train system Basics of aerodynamics, principles of aerodynamics, fluid mechanics and airflow dynamics, Suspension and Braking system, Vehicle stability control and vehicle safety,	CO1	(4)
<b>Unit 3</b>	Sketching of automotive EV design: Introduction to Automotive sketching software, Overview of vehicle design process and Automotive sketching, Basic sketching techniques.	CO2	(4)
<b>Unit 4</b>	Software for EV drafting and designing Basic sketching techniques and tools in the software, sketching car exteriors, interiors and details. creating different views and angles of vehicle	CO3	(4)
<b>Unit 5</b>	Advance EV modeling techniques using Solidworks : Basic vehicle design principles, design and modeling of chassis and frame, suspension systems, design and modeling of braking and steering systems, automotive sketching softwares, advance body design modeling.	CO4	(4)
<b>Unit 6</b>	Advance EV analysis using different data analysis software Analyse the EV designed in modeling software using advance data analysis software, setting up modeling environment.	CO4	(4)

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1.	Julian Happian-Smith; Transport Research Laboratory (TRL) Introduction to Modern Vehicle Design, Publisher: Elsevier- edition 2001
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CO 2	2	-	2	-	2	-	1	-	-	1	-	2
CO 3	3	3	3	3	3	1	3	1	2	2	-	3
CO 4	3	3	3	3	3	1	3	1	2	1	-	2

1: Slight(Low)

2: Moderate(Medium)

3: Substantial(High)

### Assessment Pattern(with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	4	4	10
Apply	4	4	10
Analyse	4	4	20
Evaluate	4	4	10
Create	4	4	10
TOTAL	20	20	60

**Government College of Engineering, Karad**  
**Third Year (Sem – V) B. Tech. Mechanical Engineering**  
**IMI3533:EV Design, Development and Analysis**

Teaching Scheme		Examination Scheme		
Lectures	03 Hrs/week	MSE		20
Tutorials	00 Hrs/week	ISE		20
Total Credits	03	ESE		60
		Duration of ESE		02 Hrs 30 Min

**Prerequisite :** Basics of mechanical, Basics of electrical, fundamentals of EV

**Course Outcomes:**After completion of the course the student will be able to

CO1	Demonstrate various tools and techniques of modeling and simulation of EV
CO2	Design and model components of EV
CO3	Analyze EV powertrain components
CO4	Examine and simulate thermal management in EV powertrain

	Course Contents	CO	Hours
<b>Unit 1</b>	Essential for designing and simulation using MATLAB: Overview and environment, Basic variables, syntax , commands ,M-files and types, Operators decision making and loops, vector ,matrix and arrays, colon notation and numbers, string and functions	CO1	(4)
<b>Unit 2</b>	Fundamentals of EV system using MATLAB DC motor characteristics, induction to motor characteristics, Simulink model to calculate vehicle configuration,Solar PV based charger, DC-DC converter,motor controller design,	CO1	(4)
<b>Unit 3</b>	Design and modeling of EV system using MATLAB Designing DC motor and induction motor, multilevel inverter designing,	CO2	(4)
<b>Unit 4</b>	Modeling of EV power train in Solid works: Introduction to EV Power train, Modeling architecture of EV Powertrain, Modeling of EV powertrain components. Battery pack modeling in solidworks	CO2	(4)
<b>Unit 5</b>	Analysis of EV power train components: Modeling and simulation of EV powertrain components inANSYS,	CO3	(4)
<b>Unit 6</b>	Simulation of Thermal management system for EV Battery management system modeling, simulation li-ion battery pack using MATLAB	CO4	(4)

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CO 3	2	3	3	3	3	1	3	2	2	2	2	3
CO 4	3	3	3	3	3	1	3	1	2	2	2	3

1: Slight(Low)

2: Moderate(Medium)

3: Substantial(High)

### Assessment Pattern(with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	4	4	10
Apply	4	4	10
Analyse	4	4	20
Evaluate	4	4	10
Create	4	4	10
TOTAL	20	20	60



**Government College of Engineering, Karad**  
**Third Year (Sem – VI) B. Tech. Mechanical Engineering**

**IMI3635:EV Product Development, Homologation and Hydrogen 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 :** Basics understanding of EV

**Course Outcomes:** After completion of the course the student will be able to

CO1	Explain fundamentals of EV business management
CO2	Classify different EV testing parameters
CO3	State different product development methods
CO4	Describe Hydrogen vehicle and Fuelcell in Hybrid vehicles

Course Contents		CO	Hours
<b>Unit 1</b>	Introduction to Business management: Introduction to EV market and opportunities, EV market categories, regulations and standards, product development plan segment selection, product design plan, product specification-competitor analysis, development methods	CO1	(4)
<b>Unit 2</b>	Business plan and product launch: Process of making business plans, different marketing methods, product launch ideation and executions	CO1	(4)
<b>Unit 3</b>	EV testing and Homologation: FAME India and manufacturing guidelines,, EV certification process, standards for EV charging and retrofitting, EV motor parameter guidelines, batter selection criteria.	CO2	(4)
<b>Unit 4</b>	Product development methods: Design feasibility, Selection of off the shelf parts, product design validation, design for manufacturing, Vehicle dynamics selection, product planning, segment selection, product design plan, product specification, product development methods, working prototyping methods.	CO3	(4)
<b>Unit 5</b>	Introduction to Hydrogen vehicle: Introduction to future mobility, Why hydrogen based technology, essentials of hydrogen, Hydrocarbons terms in fuels, energy, flammability and safety, use of hydrocarbons in IC engine	CO4	(4)
<b>Unit 6</b>	Fuel cell in Hybrid electric vehicle: Hydrogen fuel cells techniques and systems. fuel cell engine safety and maintenance,Fuel vehicle Acts,codes,Regulations and Guidelines, maintenance and fueling Facility requirements,Fuel cells in Hybrid electric vehicle and pure electric vehicle,Auxiliary power generation using Hydrogen	CO4	(4)

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CO 2	2	-	-	-	-	3	2	3	2	3	2	2
CO 3	1	-	-	-	-	1	3	3	3	3	3	3
CO 4	2	-	-	-	-	3	3	3	3	3	3	2

### Assessment Pattern(with revised Bloom's Taxonomy)

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

**Government College of Engineering, Karad**  
**Forth Year (Sem – VII) B. Tech. Mechanical Engineering**  
**IMI3736:EV FEA ANALYSIS**

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 :** Basic understanding of EV and 3D modelling

**Course Outcomes:**After completion of the course the student will be able to

CO1	Design and analyze structure of Electric vehicle
CO2	Demonstrate FEA analysis of EV
CO3	Analyse EV model
CO4	Execute model testing for thermal analysis of radiator and external cooling mechanism

Course Contents		CO	Hours
<b>Unit 1</b>	EV design and structural analysis: Theory of FEA/CAE, Procedure of implementing FEA /CAE analysis, Introduction to hyper mesh, creating and modifying geometry, Geometry cleanup and defeature,	CO1	(4)
<b>Unit 2</b>	Mesh model development using Hyper mesh: Introduction to 2D meshing,3D meshing ,element Quality, Mesh Edit, Introduction to plastic mesh,Introduction 1D meshing ,Modal analysis	CO2	(4)
<b>Unit 3</b>	FEA analysis for EV engineering with Abaqus: Introduction to Abaqus software, fundamentals of FEA stress ,About Abaqus Software features, Create material and Create assembly,Create steps ,loads , boundary conditions ,Generate mesh ,Result visualization,1 D Analysis,Linear static analysis and linear buckling analysis.	CO2	(4)
<b>Unit 4</b>	Analyze EV dynamic and simulation: Basics of Finite-Element Analysis (FEA) along with ANSYS Tool and Software Interface, Essential Mechanical and Electrical Properties of Materials, Various Case Studies on ANSYS Mechanical	CO2	(4)
<b>Unit 5</b>	CFD analysis for EV: Basics of Computational Fluid Dynamics, Simulation of Battery Thermal Management in Electric Vehicle, Vibration and Fatigue Analysis of Battery Pack,	CO3	(4)
<b>Unit 6</b>	Thermal analysis of EV: Thermal Analysis of Liquid-Cooled Radiator, CFD Study of External Cooling Mechanism for Battery Pack.	CO4	(4)

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CO 2	2	2	3	2	3	1	3	1	2	1	-	2
CO 3	3	3	2	3	2	1	2	2	1	2	-	2
CO 4	3	3	3	3	3	1	3	1	2	12	-	3

### Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	4	4	10
Apply	4	4	10
Analyse	4	4	20
Evaluate	4	4	20
Create	-	-	-
TOTAL	20	20	60

**Government College of Engineering, Karad**  
**Forth Year (Sem – VIII) B. Tech. Mechanical Engineering**  
**IMI3837:CYBER SECURITY AND DATA ANALYSIS**

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 :** Basics understanding of EV

**Course Outcomes:**After completion of the course the student will be able to

CO1	Describe Data analysis techniques and methods
CO2	Demonstrate of software involved in data analysis
CO3	Classify different techniques of cyber security implementation
CO4	Explain different vehicle parking and driving methods

	Course Contents	CO	Hours
<b>Unit 1</b>	Introduction to Data analysis: Introduction to Data analytics and application in automotive industry, data analysis pipeline,	CO1	(4)
<b>Unit 2</b>	Data analysis tools and techniques: EV data collection and analysis, data preprocessing, static analysis and of EV data,	CO1	(4)
<b>Unit 3</b>	Software involved in data analysis: Overview of different software used for data analysis.	CO2	(4)
<b>Unit 4</b>	Cyber security for EV systems: Automotive megatrends, automotive electrical and electronics, automotive software technology, mobile apps for connected vehicles,	CO3	(4)
<b>Unit 5</b>	Vehicle parking and charging Methods: vehicle sharing connected parking and automated parking systems	CO3	(4)
<b>Unit 6</b>	Autonomous vehicle systems: ADAS and autonomous driving, different vehicle autonomous classifications	CO4	(4)

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CO 2	2	-	-	-	2	2	2	3	-	2	-	2
CO 3	2	-	-	-	-	3	3	2	-	3	-	3
CO 4	2	-	-	-	-	2	3	3	-	3	-	3

### Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	5	5	25
Understand	10	10	25
Apply	5	5	10
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-
TOTAL	20	20	60