Multi-disciplinary Minor (Institute Level-Industrial)

Electrical Vehicle

(Electrical perspective Institute Level-Industrial)

Government College of Engineering, Karad				
Second Year (Sem – III) B. Tech. Electrical				
IMI3311 Foundation of EV and Hybrid Vehicle				
Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	00 Hrs/week		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite: Basics of Electrical and Electronics.

Course Outcomes (CO): Students will be able to

CO1	Explain the fundamental concepts, principals and configuration of electric and hybrid electric vehicles
CO2	Identify the various electrical and electronics components for advanced EV
CO3	Discuss hybridization of automobile.
CO4	Illustrate the electric drive-trains characteristics.

	Course Contents	CO	Hours
Unit 1	**Introduction to EV:** • Current demand in EV industry and opportunities of skilled EV engineers, • History and evolution of electric vehicles, • Components of an electric vehicle.	CO1	(04)
Unit 2	**Electrical Engineering for EV:** • EV classification and their electrification levels • Battery technology, • Motor and controller systems, • EV numerical calculation • EV charging infrastructure.	CO1	(04)
Unit 3	**Advanced Electric Vehicles:** • Electrical Requirement, • Power Distribution Specifications, • Electronic Component System, • EV Standard Specifications • Selection of Electrical and Electronic Components.	CO2	(04)
Unit 4	**Hybridization of the Automobile:** • Challenges and Key Technology of HEVs. • Basics of Hybrid Electric Vehicle (HEV) • Basics of Plug-in Hybrid Electric Vehicles(PHEV) • Basics of Fuel Cell Vehicles (FCVs). • Vehicle to Grid technology	CO3	(04)
Unit 5	**Hybrid Electric Vehicles :** • HEVs Fundamentals, • Vehicle performance, • Configuration of HEV (Series, Parallel, Series-parallel &Complex), • Power Flow control, Examples • Operation of HEVs	CO3	(04)
Unit 6	**Hybrid Electric Drive-trains:** • Basic concept of hybrid traction, • introduction to various hybrid drive-train topologies, • power flow control in hybrid drive-train topologies,	CO4	(04)

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	• fuel efficiency analysis. **Electric Drive-trains:** • Basic concept of electric traction, • introduction to various electric drive-train topologies, • power flow control in electric drive-train topologies, • fuel efficiency analysis.		

Text Books	
1.	Electric And Hybrid Electric Vehicles Braking Systems & NVH considerations, Author Jurgen R.K., Publisher - Sae International
Reference Books	
1.	Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2nd Edition, 2003.
2.	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004
3.	James Larminie, John Lowry, "Electric Vehicle Technology", Wiley publications, 1st Edition, 2003.
4.	B D McNicol, D A J Rand, "Power Sources for Electric Vehicles", Elsevier publications, 1st Edition, 1998
5.	Seth Leitman, "Build Your Own Electric Vehicle" MC Graw Hill, 1st Edition, 2013
Useful Links	
1.	https://archive.nptel.ac.in/courses/108/102/108102121/
2.	https://nptel.ac.in/courses/108/103/108103009/

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

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

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	5	5	5
Understand	5	5	20
Apply	5	5	15
Analyse	5	5	20
Evaluate	-	-	-
Create	-	-	-
TOTAL	20	20	60

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Second Year (Sem – IV) B. Tech. Electrical

IMI3412: EV Battery Technology and Powertrain Development

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

Prerequisite : Electrostatics and Basic Circuit Laws.

Course Outcomes (CO): Students will be able to

CO1	Analyze the performance of the batteries.
CO2	Discuss and Analyze different energy storage technologies used for hybrid electric vehicles.
CO3	Implement proper drive configuration to electric and hybrid vehicle.
CO4	Visualize the working of an EV powertrain.

	Course Contents	CO	Hours
Unit 1	**Batteries:** Overview of Batteries,Battery Parameters,Lead acid batteries,Lithium ion batteries, Metal air batteries,Battery Charging,Thermal runway battery management system (BMS), Functionality,SOC/SOH estimation.	CO1	(04)
Unit 2	**Energy Storage Systems for EV:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles,Different batteries for EV,Battery CharacterizationComparison of Different Energy Storage Technologies for HEVs, Battery Charging Control	CO2	(04)
Unit 3	**Energy Storage and its analysis:** Battery based energy storage and its analysis,Solar Photovoltaic based energy storage system, Fuel Cell based energy storage and its analysis,Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis,Hybridization of different energy storage devices	CO2	(04)
Unit 4	**Battery Pack Design and Modeling** Battery pack Design,Properties of Batteries,Battery Pack Assembly and Test, Thermal Analysis on Battery Pack, Battery Pack Modeling,The basics of charging technology Types of charging architecture existing globally,CAN communication	CO1	(04)
Unit 5	**Electric Propulsion unit:** Introduction to electric components used in hybrid and electric vehicles,Configuration and control of DC Motor drives,Configuration and control of Induction Motor drives,configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, Drive system efficiency	CO3	(04)
Unit 6	**Electric Vehicle Powertrain:** Introduction to EV Powertrain, Special electric traction motors,Various types of regulations and standards set in the CMVR (Central Motor Vehicles Rules - 1989) for selecting and manufacturing various components of an electric vehicle. The rules and regulations need to follow while designing a retrofit powertrain model. Architecture and Components of EV Powertrain, Basics of Carbon footprint of companies and understand how companies utilize carbon credits to reduce their carbon footprint issues	CO4	(04)

Text Books

1. Handbook on Battery Energy Storage System,ASIAN DEVELOPMENT BANK,2018
2. Handbook of Automotive Powertrain and Chassis Design

Reference Books

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2nd Edition, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004
3. James Larminie, John Lowry, "Electric Vehicle Technology", Wiley publications, 1st Edition, 2003.
4. B D McNicol, D A J Rand, "Power Sources for Electric Vehicles", Elsevier publications, 1st Edition, 1998
5. Seth Leitman, "Build Your Own Electric Vehicle" MC Graw Hill, 1st Edition, 2013

Useful Links

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1.	https://nptel.ac.in/courses/108106170
2.	https://onlinecourses.swayam2.ac.in/ntr24_ed16/preview

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

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

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	5	5	5
Understand	5	5	20
Apply	5	5	15
Analyse	5	5	20
Evaluate	-	-	-
Create	-	-	-
TOTAL	20	20	60

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Third Year (Sem – V) B. Tech. Electrical

IMI3513: EV Charging Infrastructure, Vehicle Testing and Homologation

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

Prerequisite : Basics of Power Electronics Converters.

Course Outcomes (CO): Students will be able to

CO1	Discuss the electric vehicle market, opportunities and challenges
CO2	Illustrate different EV development methods and unit economics
CO3	Describe the EV charging technologies, standards and protocols.
CO4	Execute site selection and planning infrastructure design

	Course Contents	**CO**	**Hours**
Unit 1	**Fundamentals of EV Management:** Introduction to EV Market, EV Design Procedure and ICE Model, EV Management, EV Homologation and Testing.	CO1	(04)
Unit 2	**Charger Manufacturing:** FAME India and Manufacturing Guidelines, EV Certification Process, EV Charging, Electric Vehicle and Retrofitting, EV Categories and Proposed Chargers.	CO1	(04)
Unit 3	**Product Development Plan:** Segment Selection, Product Design Plan, Product Validation Plan, Vehicle Dynamics Selection, Product Design Validation, Product Selection Plan.	CO2	(04)
Unit 4	**Development Methods:** Product Development Methods, Product Development Plans, Unit Economics, Design feasibility, Design for Manufacturing.	CO2	(04)
Unit 5	**EV Charging Technology:** Overview, Charging Standards.	CO3	(04)
Unit 6	**Charging Infrastructure and Site Selection:** EV Charging Infrastructure Design, Site Selection and Planning, Safety and Regularities.	CO4	(04)

Handbook

1. https://www.niti.gov.in/sites/default/files/2023-02/EV_Handbook_Final_14Oct.pdf
2. https://sarepenergy.net/wp-content/uploads/2023/07/EV-Technican-Handbook-SAREP.pdf

Reference Books

1. Electric And Hybrid Vehicles Design Fundamentals, Author Husain Iqbal.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles ,Fundamentals Theory and Design Author Ehsani M.,Gao Yimin , Emadia A. Crc Press Newyork.

Useful Links

1. https://onlinecourses.nptel.ac.in/noc20_ee99/preview
2. https://nptel.ac.in/courses/108/103/108103009/
3. https://onlinecourses.swayam2.ac.in/ntr24_ed54/preview

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

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

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	5	05
Apply	5	5	20
Analyse	5	5	20
Evaluate	5	5	15
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad				
Third Year (Sem –V) B. Tech. Electrical Engineering				
IMI3514:Electric Vehicle Lab				
Laboratory Scheme:			**Examination Scheme:**	
Practical	2 Hrs/week		**ISE**	50
Total Credits	**1**		**ESE**	--
			TOTAL: 50	

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 ANSYS	CO3
Experiment 11	Battery Management System modelling	CO3
Experiment 12	Modelling of Li-ion battery pack using MATLAB and ANSYS	CO3

List of Submission:
Minimum number of Experiments: 08

Mapping of COs and POs:

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

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

Assessment Pattern:

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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Third Year (Sem – VI) B. Tech. Electrical

IMI3615: EV Power Electronics and Embedded System

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 Electronics

Course Outcomes (CO): Students will be able to

CO1	Select proper machine drive for HEVs application.
CO2	Compare different power converters topologies in HEVs
CO3	Develop the basic fundamentals of embedded system , C++ and Linux programming.
CO4	Discuss the sensor characteristics, communication protocol and configuration of the embedded systems

	Course Contents	**CO**	**Hours**
Unit 1	**Electric Machines and Drives in HEVs :** Introduction, BLDC motors, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modelling of Traction Motors. **(only functional treatment to be given)** .	**CO1**	**(04)**
Unit 2	**Power Electronics in HEVs:** Power electronics including switching, AC-DC, DC-AC conversion, Electronic devices and circuits used for control and distribution of electric power, Thermal Management of HEV Power Electronics,Generator and Basics of controlling System in Hybrid Vehicle.		
Unit 3	**Power Converter:** Introduction, various power electronics converter topologies and its comparisons, Control of convertor operations in EV and HV, EV Charging and Battery System ,Emerging power electronic devices ,PE in renewable energy system, PE in industrial system	**CO2**	**(04)**
Unit 4	**Introduction to Embedded System:** Microcontrollers and microprocessors in EVs,Basics of Embedded System, Embedded C/C++ programming, Idea about Linux, Linux in Embedded System.	**CO4**	**(04)**
Unit 5	**Sensor Characteristics and communication Protocols:** Sensor Principal Characteristics, Sensor-Actuator Integration System. Basic introduction to communication protocols CAN bus,LIN, FlexRay.	**CO4**	**(04)**
Unit 6	**Configuration of Embedded System:** Building of Linux-Embedded System, Application in Embedded Devices, Real-Time Operating Systems (RTOS), RTOS concepts and usage in EVs, Scheduling and task management	**CO4**	**(04)**

Handbooks

1.	https://d1.amobbs.com/bbs_upload782111/files_38/ourdev_629261ASTZIF.pdf
2.	Ersan Kabalci ,Power Electronics and Drives Used In Automotive Applications

Reference Books

1.	Power Electronics: Principles and Applications, Joseph Vithayathil, McGraw Hill Publication, 2010
2.	Power Electronics, Cyril W. Lander, 3rd Edition McGraw Hill publication
3.	Frank Vahid and Tony Givargis, Embedded system design: A unified hardware/Software introduction, Third edition, John Wiley & sons, 2010

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4.	L. Ashok Kumar, S. Albert Alexander, "Power Converters for Electric Vehicles", CRC Press, Taylor & Francis Group, 2021
5.	Automotive Industry Standards, India, 2015-2016
Useful Links	
1.	https://nptel.ac.in/courses/108/101/108101038/ (Prof. B. G. Fernandes)
2.	https://nptel.ac.in/courses/108/102/108102145/ (Prof. G. Bhuvaneshwari)

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

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

Assessment Pattern (with revised Bloom's Taxonomy)

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

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Final Year (Sem – VII) B. Tech. Electrical

IMI3716: EV Vehicle Design and Analysis

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

Prerequisite : Semiconductor Devices Knowledge

Course Outcomes (CO): Students will be able to

CO1	Apply the power electronics technique to diagnostics fault
CO2	Explore the knowledge about analog and digital electronics
CO3	Develop the EV architecture with the help of design and simulation parameters.
CO4	Design and modelling the different EV units.

	Course Contents	**CO**	**Hours**
Unit 1	**Analog Electronics:** Sensors for EV Applications (Temperature, Pressure, Current, Voltage) Signal Conditioning Circuits (Amplifiers, Filters) Interface Circuits (Analog-to-Digital Converters)	**CO2**	**(04)**
Unit 2	**Power Electronics:** Pulse Width Modulation (PWM) Techniques Current and Voltage Regulation Over current and Overvoltage Protection Fault Detection and Diagnostics.	**CO1**	**(04)**
Unit 3	**Digital Electronics:** Analog-to-Digital Conversion (ADC) Sensor Types and Characteristics (Temperature, Pressure, Acceleration, etc.) Signal Conditioning Circuits Filtering and Noise Reduction Techniques	**CO2**	**(04)**
Unit 4	**Automotive Components:** Power Semiconductors, Trends in Power semiconductors, Bidirectional Converters, Inverters, Interleaving mode in power converters, Passive Components	**CO3**	**(04)**
Unit 5	**EV Architecture:** Motor development and induction motor characteristics,Simulink model to calculate vehicle configuration,Multilevel inverter design and simulation,DC –DC converter, Motor controllers	**CO3**	**(04)**
Unit 6	**Modelling and Simulation of Electric Vehicles:** Modeling and sizing of the traction systems,Modeling and sizing of the storage systems,Modeling of EV battery and BMS,Interaction between the different blocks of the electrical Architecture	**CO4**	**(04)**

Handbooks

1. K. T. Chau ,Electric Vehicle Machines and Drives: Design, Analysis and Application,ISBN: 978-1-118-75252-4,August 2015,Wiley-IEEE Press
2. Per Enge ,Nick Enge, Stephen Zoepf,"Electric Vehicle Engineering", 1st Edition, McGraw Hill publication 2021
3. Handbook of Power Electronics in Autonomous and Electric Vehicles

Reference Books

1. M. S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley & Sons Inc.
2. Michael Shur, Introduction to Electronic Devices, John Wiley & Sons Inc., 2000.
3. R. T. Howe and C. G. Sodini, Microelectronics: An Integrated Approach, PrenticeHall Inc. 1997.
4. Jacob Millman, and C.C. Halkias, "Electronic devices and circuits", TMH Publications
5. Ben G. Streetman, Solid State Electronic Devices, PHI, 5th Ed, 2001

Useful Links

1. http://web.iitd.ac.in/~shouri/eel201/lectures.php
2. http://www.daenotes.com/electronics/digital-electronics
3. https://onlinecourses.nptel.ac.in/noc24_ee30/preview

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4.	https://onlinecourses.nptel.ac.in/noc22_ee53/preview

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

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

Assessment Pattern (with revised Bloom's Taxonomy)

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

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Government College of Engineering, Karad				
Final Year (Sem – VIII) B. Tech. Electrical				
IMI3817: EV PCB Design & Data Analytics				
Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	00 Hrs/week		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Basics of Analog and Digital Electronics

Course Outcomes (CO): Students will be able to

CO1	Discuss the basics of PCB Design and its components.
CO2	Organize and execute hierarchical schematics of EV
CO3	Explore ideas about data visualization.
CO4	Analyze data for electric and autonomous vehicles.

	Course Contents	CO	Hours
Unit 1	**Basics of PCB Design:** Overview, Basic Ideas, Different Technologies, Understanding Schematic Capture.	CO1	(04)
Unit 2	**Component Working:** Symbol and Nets, Creating Hierarchical Schematic, Multi Sheet Design, Generating Netlist and Bill of Material.	CO2	(04)
Unit 3	**Design Applications :** Design for Analog and Digital Circuits, Design for Power Electronics, Design for Microwave circuits.	CO1	(04)
Unit 4	**Data Analytics:** Introduction, Data Collection, Preprocessing, Data Collection Techniques in Electric Vehicle.	CO4	(04)
Unit 5	**Data Visualization:** Introduction to Data Visualization Technique, Data Exploration, Data Exploration for EV.	CO3	(04)
Unit 6	**Overview and Application of Data Analysis:** Overview of Data Analysis Techniques, Regression Analysis, Clustering, Application in EV Electrical System, Data Analysis Platform for EV System.	CO4	(04)

Handbook

1. P-CAD PCB User's Guide

Reference Books

1. IPC-PCB Design Desk Reference 2022 Edition
2. PCB Designing E- Learning Book, Sai Kiran

Useful Links

1. https://resources.pcb.cadence.com/ebooks-white-papers

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

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

Assessment Pattern (with revised Bloom's Taxonomy)

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

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Multi-disciplinary Minor (Institute Level-Industrial)

Electrical Vehicle (Mechanical Engineering- Institute Level-Industrial)

Government College of Engineering, Karad

Second Year (Sem – III) MDM- Electrical Vehicle (Mechanical Engineering- Institute Level-Industrial)

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: 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
Unit 1	**Introduction to EV:** Explaining EV technology and summarize Automotive revolution, explore Electrical Requirement of a vehicle.	CO1	(04)
Unit 2	**EV layout and components:** Exploring different types of EV layouts and basic components of Electric Vehicle	CO1	(04)
Unit 3	**Introduction to Hybrid electric vehicle:** Defining Hybrid Vehicle working principles and architecture, Introduction, Battery chemistry ,Efficiency ,Definition and parameters for Hybrid Systems	CO2	(04)
Unit 4	**Layout and component of hybrid electric vehicle :** Electric Motors ,Generators , and Power electronics for Hybrid systems, control systems, Hybrid electric vehicle operation	CO2	(04)
Unit 5	**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	(05)
Unit 6	**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	(05)

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 - 3rd edition-feb 2013

Reference links

1. https://www.carbodydesign.com/
2. https://www.team-bhp.com/
3. https://autoprotoway.com/automotive-design-process/
4. https://www.carbodydesign.com/

Government College of Engineering, Karad

Second Year (Sem – IV) MDM- Electrical Vehicle (Mechanical Engineering- Institute Level-Industrial)

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: 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**
Unit 1	**Introduction to vehicle dynamics:** Fundamentals of vehicle dynamics, different mechanisms and dynamics involved in wheels, fundamentals of Hybrid vehicle dynamics.	**CO1**	**(04)**
Unit 2	**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**	**(04)**
Unit 3	**Sketching of automotive EV design:** Introduction to Automotive sketching software, Overview of vehicle design process and Automotive sketching, Basic sketching techniques.	**CO2**	**(04)**
Unit 4	**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**	**(05)**
Unit 5	**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**	**(05)**
Unit 6	**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**	**(04)**

Reference Books

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

Reference links

1.	https://www.carbodydesign.com/
2.	https://www.team-bhp.com/
3.	https://autoprotoway.com/automotive-design-process/
4.	https://www.carbodydesign.com/

Professor and Head of the
Dept. of Mechanical Engineering
Govt. College of Engineering, KARAD

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	-	2	-	-	2	-	3
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

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जा.क्र.शं.अभक/ 324
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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Govt. College of Engg., Karad

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
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.	"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
	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	-	-	-	-	-	-	1	2	3
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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Mechanical Engineering Dept.
Govt. College of Engg., Karad

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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Mechanical Engineering Dept.
Govt. College of Engg., Karad

Government College of Engineering, Karad

Final Year (Sem – VII) MDM- Electrical Vehicle (Electrical Engineering- Institute Level-Industrial)

IMI3716: EV Vehicle Design, Analysis and Control

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

Prerequisite : Semiconductor Devices Knowledge

Course Outcomes (CO): Students will be able to

CO1	Apply the power electronics technique to diagnostics fault
CO2	Explore the knowledge about analog and digital electronics
CO3	Develop the EV architecture with the help of design and simulation parameters.
CO4	Design and modelling the different EV units.

	Course Contents	**CO**	**Hours**
Unit 1	**Analog Electronics:** Sensors for EV Applications (Temperature, Pressure, Current, Voltage) Signal Conditioning Circuits (Amplifiers, Filters) Interface Circuits (Analog-to-Digital Converters)	**CO2**	**(04)**
Unit 2	**Power Electronics:** Pulse Width Modulation (PWM) Techniques Current and Voltage Regulation Over current and Overvoltage Protection Fault Detection and Diagnostics.	**CO1**	**(04)**
Unit 3	**Digital Electronics:** Analog-to-Digital Conversion (ADC) Sensor Types and Characteristics (Temperature, Pressure, Acceleration, etc.) Signal Conditioning Circuits Filtering and Noise Reduction Techniques	**CO2**	**(04)**
Unit 4	**Automotive Components:** Power Semiconductors, Trends in Power semiconductors, Bidirectional Converters, Inverters, Interleaving mode in power converters, Passive Components	**CO3**	**(04)**
Unit 5	**EV Architecture:** Motor development and induction motor characteristics, Simulink model to calculate vehicle configuration, Multilevel inverter design and simulation, DC –DC converter, Motor controllers	**CO3**	**(05)**
Unit 6	**Modelling and Simulation of Electric Vehicles:** Modeling and sizing of the traction systems, Modeling and sizing of the storage systems, Modeling of EV battery and BMS, Interaction between the different blocks of the electrical Architecture	**CO4**	**(06)**

Handbooks

1. K. T. Chau ,"Electric Vehicle Machines and Drives: Design, Analysis and Application", Wiley-IEEE Press, ISBN: 978-1-118-75252-4, August 2015.
2. Per Enge ,Nick Enge, Stephen Zoepf, "Electric Vehicle Engineering", 1st Edition, McGraw Hill publication 2021
3. Nicolas Navet, Francois Simonot-Lion, "Automotive Embeded Systems Handbook", CRC Press Taylor&Francic group, 2009.

Reference Books

1. M. S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley & Sons Inc.
2. Michael Shur, Introduction to Electronic Devices, John Wiley & Sons Inc., 2000.
3. R. T. Howe and C. G. Sodini, Microelectronics: An Integrated Approach, PrenticeHall Inc. 1997.
4. Jacob Millman, and C.C. Halkias, "Electronic devices and circuits", TMH Publications
5. Ben G. Streetman, Solid State Electronic Devices, PHI, 5th Ed, 2001

Useful Links

1. http://web.iitd.ac.in/~shouri/eel201/lectures.php
2. http://www.daenotes.com/electronics/digital-electronics
3. https://onlinecourses.nptel.ac.in/noc24_ee30/preview

Government College of Engineering, Karad

Final Year (Sem – VIII) MDM- Electrical Vehicle (Electrical Engineering- Institute Level-Industrial)

IMI3817: EV PCB Design & Data Analytics

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

Prerequisite : Basics of Analog and Digital Electronics

Course Outcomes (CO): Students will be able to

CO1	Discuss the basics of PCB Design and its components.
CO2	Organize and execute hierarchical schematics of EV
CO3	Explore ideas about data visualization.
CO4	Analyze data for electric and autonomous vehicles.

	Course Contents	CO	Hours
Unit 1	**Basics of PCB Design:** Overview, Basic Ideas, Different Technologies, Understanding Schematic Capture.	**CO1**	**(04)**
Unit 2	**Component Working:** Symbol and Nets, Creating Hierarchical Schematic, Multi Sheet Design, Generating Netlist and Bill of Material.	**CO2**	**(05)**
Unit 3	**Design Applications :** Design for Analog and Digital Circuits, Design for Power Electronics, Design for Microwave circuits.	**CO1**	**(04)**
Unit 4	**Data Analytics:** Introduction, Data Collection, Preprocessing, Data Collection Techniques in Electric Vehicle.	**CO4**	**(04)**
Unit 5	**Data Visualization:** Introduction to Data Visualization Technique, Data Exploration, Data Exploration for EV.	**CO3**	**(04)**
Unit 6	**Overview and Application of Data Analysis:** Overview of Data Analysis Techniques, Regression Analysis, Clustering, Application in EV Electrical System, Data Analysis Platform for EV System.	**CO4**	**(05)**

Handbook

1. "P-CAD PCB User's Guide", p-cad PCB layout system from Altum,2006.

Reference Books

1. "IPC-PCB Design Desk Reference 2022 Edition", IPC design,2022.
2. Sai Kiran "PCB Designing E- Learning Book", Digimind 2009.

Useful Links

https://resources.pcb.cadence.com/ebooks-white-papers

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

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

Multi-disciplinary Minor (Institute Level-Industrial)

Image Processing (Institute Level-Industrial)

Government College of Engineering, Karad				
Second Year (Sem – III) MDM- Image Processing (Institute Level-Industrial)				
IMI3321: Fundamentals of Image				
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 : Mathematics basics

Course Outcomes (CO): Students will be able to

CO1	Understand the image fundamentals
CO2	Study the Image perception
CO3	Explain different operations applied to Medical Images
CO4	Apply various image transformation procedures used in health care

	Course Contents	CO	Hours
Unit 1	**Fundamentals of Image :** Fundamentals of Image and Pictures, Analog image and Digital Image, Elements of Visual perception, Image sampling and quantization,	**CO1**	**(04)**
Unit 2	**Different Types of Image:** Image Perception, Greyscale Images, RGB Images, Indexed Colour Images, Medical Images.	**CO1, CO2**	**(04)**
Unit 3	**Representation of Image:** Camera Models , Imaging Geometry, Basics Of Image Display, Data Types And Conversions	**CO1, CO2**	**(04)**
Unit 4	**Image Operations:** Neighborhood Pixel Relationships, Basic Image Operations - Arithmetic, Geometric And Morphological	**CO3**	**(04)**
Unit 5	**Transformation:** Image Transform: 2d Dft- Discrete Cosine, Sine , Haar Transform, Walsh Transform.	**CO4**	**(05)**
Unit 6	Case study 1. Medical Image Display using MATLAB /Python Case Study 2. Representation of Grey and RGB images using MATLAB /Python Case study 3. Different Operations on Images.	**CO4**	**(05)**

Text Books

1.	Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2010.
2.	Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011 An Introduction to Digital Image Processing with Matlab, Alasdair McAndrew

References

1.	Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
2.	Willliam K Pratt, "Digital Image Processing", John Willey, 2002.

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3.	Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", First Edition, PHI Learning Pvt. Ltd., 2011.
Useful Links	
1.	https://onlinecourses.nptel.ac.in/noc19_ee55/preview
2.	https://www.coursera.org/specializations/image-processing
3.	https://www.coursera.org/learn/introduction-image-processing

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

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

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	5	05
Apply	5	5	20
Analyse	5	5	20
Evaluate	5	5	15
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad				
Second Year (Sem – IV) MDM- Image Processing (Institute Level-Industrial)				
IMI3422: Basics of Image Processing for Healthcare				
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 : Digital Signal Processing basics

Course Outcomes (CO): Students will be able to

CO1	Study digital image fundamentals.
CO2	Explain image enhancement and restoration, compression, segmentation techniques

	Course Contents	CO	Hours
Unit 1	**Fundamentals of Image Processing:** Digital Image Representation – Fundamental Steps In Image Processing, Components Of An Image Processing System.	**CO1**	**(03)**
Unit 2	**Image Enhancement In The Spatial Domain:** Some Basic Gray Level Transformation, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics Of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters.	**CO1, CO2**	**(04)**
Unit 3	**Image Enhancement In The Frequency Domain:** Introduction To The Fourier Transform And The Frequency Domain, Smoothing Frequency-Domain Filters, Sharpening Frequency-Domain Filters, Homomorphic Filtering.	**CO2**	**(04)**
Unit 4	**Image Restoration:** A Model Of The Image Degradation/Restoration Process, Linear, Position Invariant Degradations, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering. Wavelets And Multi Resolution Processing: Multi Resolution Expansions, Wavelet Transforms In One Dimension, The Fast Wavelet Transform, Wavelet Transforms In Two Dimensions	**CO2**	**(06)**
Unit 5	**Image Compression and segmentation:** Image Compression Models, Error-Free Compression, Lossy Compression, Image Compression Standards, Detection Of Discontinuities, Edge Linking And Boundary Detection, Thresholding, Region-Based Segmentation	**CO2**	**(05)**
Unit 6	**Object Representation And Description:** Various Schemes For Representation, Boundary Descriptors, And Regional Descriptors	**CO2**	**(04)**

Text Books

1. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2010.

References

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
2. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", First Edition, PHI Learning Pvt. Ltd., 2011.

Useful Links

1. https://onlinecourses.nptel.ac.in/noc19_ee55/preview

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2.	https://www.coursera.org/learn/introduction-computer-vision-watson-opencv

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	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	2	1	-	-	-	-	-	-	2	3	2	1
CO 2	2	2	1	1	1	-	-	-	-	-	-	1	3	2	-

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

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	5	05
Apply	5	5	20
Analyse	5	5	20
Evaluate	5	5	15
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad

Third Year (Sem – V) MDM- Image Processing (Institute Level-Industrial)

IMI3523: Particle Size Analysis using Image Processing

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 Image Processing

Course Outcomes (CO): Students will be able to

CO1	Understanding of particle size analysis techniques and their applications in health care
CO2	Apply Methods of particle size Measurements by microscopic technique
CO3	Develop interpretation of particle size distribution data and analyzing particle morphology.

	Course Contents	**CO**	**Hours**
Unit 1	**Principles of Particle Size Analysis:** Particle size analysis, image segmentation, thresholding, edge detection, contour analysis, size distribution, automation, accuracy, reproducibility	**CO1**	**(05)**
Unit 2	**Techniques in Particle Size Measurement**:Image acquisition, preprocessing, thresholding, edge detection, contour analysis, morphological operations, segmentation, particle sizing, shape analysis, Feret's diameter, equivalent diameter, circularity, convex hull, histogram analysis, statistical measurement	**CO1, CO2**	**(07)**
Unit 3	**Interpretation of Particle Size Distribution Data**:Size distribution, histogram, mean, median, mode, standard deviation, statistical analysis, graphical interpretation, accuracy assessment.	**CO3**	**(07)**
Unit 4	**Particle Morphology Analysis**:Particle shape, size, aspect ratio, circularity, roundness, convexity, solidity, surface texture, edge definition, fractal dimension, shape descriptors, contour analysis, morphology classification, structural properties, material characterization.	**CO3, CO4**	**(07)**
Unit 5	**Particle Size Analysis in health care medical system and Biomedical Samples**:Feature extraction, particle tracking, morphological operations, size distribution, shape analysis, fluorescence imaging, medical image processing, microscopy analysis.	**CO3**	**(07)**
Unit 6	***Introduction of MATLAB*** :Operations used for image processing, Image sampling and quantization, Study of DICOM standards. Histogram Processing and Basic Thresholding functions, Image Enhancement-Spatial filtering,	**CO1, CO2**	**(07)**

Text Books

1. G.R. Sinha, Bhagwaticharan patel, Medical Image Processing: Concepts and Applications, PHI Learning private limited.2014
2. KayvanNajarian and Robert Splinter, "Biomedical Signal and Image Processing", Second Edition, CRC Press, 2005.
3. E. R. Davies, "Computer & Machine Vision", Fourth Edition, Academic Press, 2012

References

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1.	Geoff Dougherty, Medical Image Processing: Techniques and Applications, Springer Science & Business Media, 25-Jul-2011
2.	Isaac N. Bankman, Handbook of Medical Image Processing and Analysis, Science Direct,2nd Edition , 2009
3.	Deserno T M, "Biomedical Image Processing", Springer, 2011.

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	PSO 1	PSO 2	PSO 3
CO 1	-	1	3	3	2	1	-	-	-	-	-	1	2	2	1
CO 2	-	3	3	2	2	1	-	-	-	-	-	1	1	2	1
CO 3	-	3	3	2	2	1	-	-	-	-	-	2	2	3	2

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

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	5	05
Apply	5	5	20
Analyse	5	5	20
Evaluate	5	5	15
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad				
Third Year (Sem – V) MDM- Image Processing (Institute Level-Industrial)				
IMI3524: Particle Size Analysis using Image Processing Lab				
Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	-
Tutorials	-		ISE	50
Total Credits	01		ESE	-

Course Contents	
Prerequisite : Basics of Image Processing	
Course Outcomes (CO): Students will be able to	
CO1	Identify and describe the different tools and instruments used in particle characterization and formulation analysis.
CO2	Prepare and organize the laboratory environment, ensuring all equipment is correctly set up for experiments.
CO3	Execute particle characterization and morphological analysis procedures independently, demonstrating proficiency and accuracy.
	Course Contents
Experiment 1	**Principles of Particle Characterization in Formulations:** Image acquisition, prepossessing, thresholding, edge detection, contour analysis, size distribution, shape analysis, aspect ratio, circularity, Feret's diameter, equivalent diameter, texture analysis, feature extraction, statistical analysis.
Experiment 2	**Techniques in Reverse Engineering of Formulations**: Digital reconstruction, segmentation, pixel intensity analysis, structural analysis, feature mapping, algorithm development, computational modeling, spectral imaging, microscopy enhancement.
Experiment 3	**Classification Analysis of Formulated Products, Morphological Characterization of Formulations :**Based on different morphological parameters, pharmaceutical formulations, cosmetic formulations, biomedical applications.
Experiment 4	**Microscopic Analysis of Formulated Products, Advanced Topics in Formulation Characterization**:High-resolution imaging, digital image processing, particle morphology, spectral imaging, fluorescence microscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM), thresholding, edge detection, feature extraction, material characterization.

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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	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	3	3	-	1	-	2	2	-	2	-	2	2
CO 2	1	3	3	2	2	1	3	1	2	-	2	2	1	2	2
CO 3	1	3	3	2	2	1	-	2	2	-	2	2	1	2	2

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

Assessment Pattern:

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

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Government College of Engineering, Karad				
Third Year (Sem – VI) MDM- Image Processing (Institute Level-Industrial)				
IMI3625: Advanced Topics in Digital Image Processing				
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 Image processing

Course Outcomes (CO): Students will be able to

CO1	Understand of particle characterization techniques used in the health care sector.
CO2	Analyse the morphology, structure, and properties of particles.
CO3	Apply particle characterization techniques in health care medical research, formulation development, and quality control.

	Course Contents	CO	Hours
Unit 1	**Advanced Image Enhancement and Restoration:**Review of image degradation models,Noise models and estimation techniques,Image restoration using inverse and Wiener filtering,Constrained least squares filtering,Advanced spatial filtering techniques,Performance measures for enhancement and restoration	CO1	(04)
Unit 2	**Multi-Resolution Image Analysis:**· Introduction to multi-scale image representation,Image pyramids: Gaussian and Laplacian pyramids,Wavelet transform fundamentals,Discrete wavelet transform (DWT) for images,Applications of wavelets in image analysis,Comparison of Fourier and wavelet approaches.	CO2	(04)
Unit 3	**Advanced Image Segmentation Techniques:** Limitations of classical segmentation methods,Clustering-based segmentation (K-means, fuzzy C-means),Graph-based segmentation concepts,Watershed transformation (advanced use cases),Active contours and level set methods (conceptual), Evaluation of segmentation performance.	CO1, CO2	(04)
Unit 4	**Feature Learning and Texture Analysis:**Advanced texture analysis techniques,Gray Level Co-occurrence Matrix (GLCM),Local Binary Patterns (LBP),Scale-invariant feature transform (SIFT) – concepts,· Feature selection and dimensionality reduction,Applications of texture-based classification.	CO3	(04)
Unit 5	**Image-Based Machine Learning and Classification:**· Review of pattern recognition concepts,· Supervised vs unsupervised learning in image analysis, · Feature-based classification pipelines,Support Vector Machines (SVM) for image classification,k-NN and decision tree classifiers,· Performance evaluation and cross-validation.	CO3,	(05)
Unit 6	**Modern Computer Vision and Industrial Applications:**Introduction to deep learning for images,Convolutional Neural Networks (CNNs) – fundamentals,Transfer learning concepts,Object detection and recognition overview,Industrial inspection and automation applications,Ethical considerations and data integrity.	CO3	(05)

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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	PSO 1	PSO 2	PSO 3
CO 1	-	2	3	3	3	-	-	-	-	1	-	1	-	2	1
CO 2	-	3	3	2	2	1	-	-	-	-	1	1	1	2	1
CO 3	-	3	3	2	2	1	-	-	-	-	-	2	1	2	2

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

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	5	05
Apply	5	5	20
Analyse	5	5	20
Evaluate	5	5	15
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad				
Final Year (Sem – VII) MDM- Image Processing (Institute Level-Industrial)				
IMI3726: Particle Characterization in Formulation and Reverse Engineering				
Teaching Scheme			**Examination Scheme**	
Practical	2 Hrs/week		MSE	20
Tutorials	-		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Basics of image processing

Course Outcomes (CO): Students will be able to

CO1	Explain the advanced knowledge and skills in particle characterization techniques applicable to health care image analysis.
CO2	Illustrate the reverse engineering methods for analysing complex formulations and identifying key components
CO3	Explain the techniques for microscopy image analytics for formulation characterization.
CO4	Apply the particle characterization techniques in formulation development, optimization, and quality control.

	Course Contents	CO	Hours
Unit 1	**Principles of Particle Characterization in Formulations:** Review of basic particle features (brief), Advanced shape and size descriptors,Aspect ratio, circularity, solidity,Feret diameters and equivalent diameter,Boundary-based and area-based parameters,Feature consistency and measurement reliability,Interpretation of particle feature data.	**CO1**	**(04)**
Unit 2	**Techniques in Reverse Engineering of Formulations:**Statistical representation of particle data,Size and shape distributions,Mean, median, mode, standard deviation,Outlier detection and data filtering,Batch-to-batch comparison using image data,Correlation between image features and material behavior.	**CO2**	**(04)**
Unit 3	**Classification Analysis of Formulated Products:** Introduction to AI and machine learning (image-based context),Concept of supervised learning,Feature-label datasets from images,Classification workflows,Algorithms:Support Vector Machine (SVM),Random Forest,k-Nearest Neighbor (k-NN),Model evaluation parameters.	**CO2**	**(04)**
Unit 4	**Morphological Characterization of Formulations:** Concept of pattern matching in image analysis,Feature similarity and distance measures,Object matching across multiple images, Handling shape and size variation,Applications in comparative image analysis.	**CO3**	**(05)**
Unit 5	**Microscopic Analysis of Formulated Products:** Introduction to time-lapse image analysis,Particle identification across image sequences,Tracking based on centroid and feature similarity,Analysis of particle movement and deformation,Case study: thermal melting and shape change of particles	**CO3**	**(05)**
Unit 6	**Advanced Topics in Formulation Characterization:** Preparation of ML-ready datasets using image-derived features and tracking outputs,Practical execution of predefined AI–ML workflows,Loading datasets,Running trained ML models,Application of AI–ML outputs	**CO4**	**(04)**

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	for:Particle grouping and classification,Identification of deviations across datasets,Validation of AI–ML outputs using image analysis results,Interpretation of predictions for quality and,process decisions,Visualization of results using tables and plots,Preparation of concise ,echnical reports based on AI–ML outcomes		

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

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

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	5	05
Apply	5	5	20
Analyse	5	5	20
Evaluate	5	5	15
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad				
Final Year (Sem – VIII) MDM- Image Processing (Institute Level-Industrial)				
IMI3827: Project/Internship				
Teaching Scheme			**Examination Scheme**	
Practical	04 Hrs/week		ISE	-
Tutorials	-		ESE	100
Total Credits	02			

Prerequisite -

Course Outcomes (CO): Students will be able to

CO1	Carry out comprehensive reverse engineering of a formulation, utilizing multiple analytical techniques to deduce the composition and structure.
CO2	Modify standard procedures to troubleshoot and optimize techniques for specific formulations, demonstrating flexibility and problem-solving skills.
CO3	Design and implement novel analytical protocols to characterize new formulations, showcasing innovation and advanced technical skills.

	Course Contents	**CO**
	Project /Internship based on the completion of previous courses.	**CO1,CO2,CO3**

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	PSO 1	PSO 2	PSO 3
CO 1	1	3	3	3	3	-	3	-	2	-	2	2	-	2	2
CO 2	-	3	3	2	2	1	2	3	-	2	2	2	1	2	2
CO 3	-	3	3	2	2	1	2	-	1	-	2	2	1	2	2

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

Assessment Pattern: (with revised Bloom's Taxonomy)

Knowledge Level	ISE	ESE
Remember	-	10
Understand	-	10
Apply	-	20
Analyse	-	20
Evaluate	-	20
Create	-	20
Total	-	100

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