

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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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.
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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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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

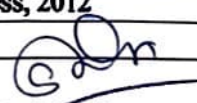
CO1	Understanding of particle size analysis techniques and their applications in health care
CO2	Apply Methods of particle size Measurements by microscopic technique
CO3	Develop interpretation of particle size distribution data and analyzing particle morphology.

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

IMI3625: Particle Characterization in 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 : 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

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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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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 technical 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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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

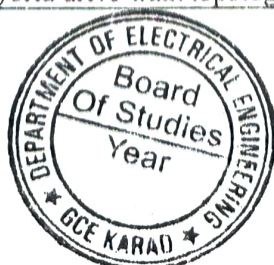
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Multi-disciplinary Minor (Institute Level-Industrial)

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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 Government College of Engineering, Karad

	• 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)

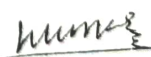
2: Moderate(Medium)

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 runaway 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)

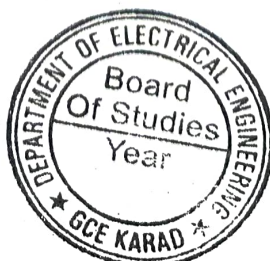
2: Moderate(Medium)

3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

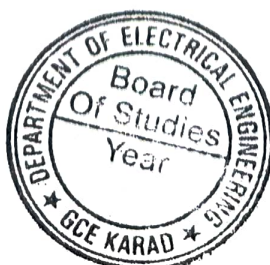
Knowledge Level	MSE	ISE	ESE
Remember	5	5	5
Understand	5	5	20
Apply	5	5	15
Analyse	5	5	20
Evaluate	-	-	-
Create	-	-	-
TOTAL	20	20	60

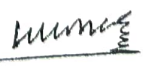
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Government College of Engineering, Karad					
Third Year (Sem – V) B. Tech. Electrical					
IMI3513: EV Charging Infrastructure, Vehicle Testing and Homologation					
Teaching Scheme			Examination Scheme		
Lectures	02 Hrs/week		MSE	20	
Tutorials	00 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	-

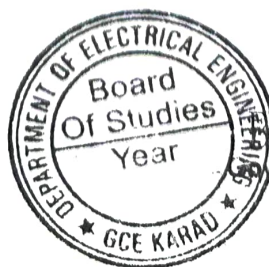
1: Slight(Low)

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	PO10	PO11	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

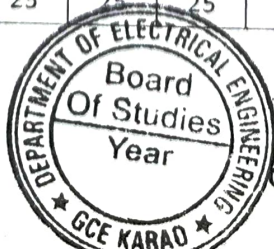
1: Slight (Low)

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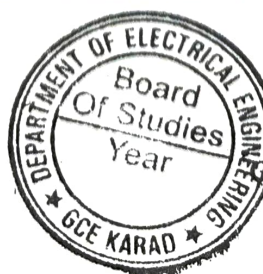
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Third Year (Sem – VI) B. Tech. Electrical

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://dl.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	-

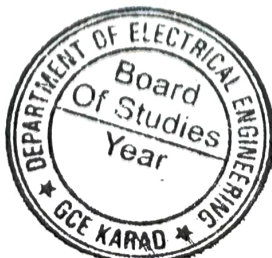
1: Slight(Low)

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

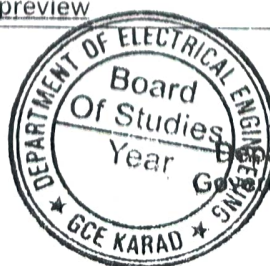
CO1	Apply the power electronics technique to diagnostics fault
CO2	Explore the knowledge about analog and digital electronics
CO3	Develop the EV architecture with the help of design and simulation parameters.
CO4	Design and modelling the different EV units.

	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-JEEE 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

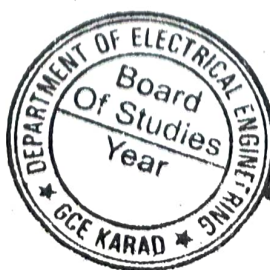
1: Slight(Low)

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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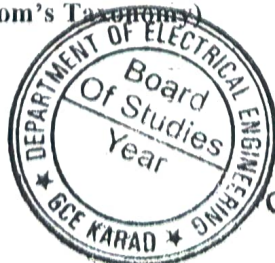
Government College of Engineering, Karad					
Final Year (Sem – VIII) B. Tech. Electrical					
IMI3817: EV PCB Design & Data Analytics					
Teaching Scheme			Examination Scheme		
Lectures	02 Hrs/week		MSE	20	
Tutorials	00 Hrs/week		ISE	20	
Total Credits	02		ESE	60	
			Duration of ESE	02 Hrs 30 Min	
Prerequisite : 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
Unit 1	Basics of PCB Design: Overview, Basic Ideas, Different Technologies, Understanding Schematic Capture.				CO1
Unit 2	Component Working: Symbol and Nets, Creating Hierarchical Schematic, Multi Sheet Design, Generating Netlist and Bill of Material.				CO2
Unit 3	Design Applications : Design for Analog and Digital Circuits, Design for Power Electronics, Design for Microwave circuits.				CO1
Unit 4	Data Analytics: Introduction, Data Collection, Preprocessing, Data Collection Techniques in Electric Vehicle.				CO4
Unit 5	Data Visualization: Introduction to Data Visualization Technique, Data Exploration, Data Exploration for EV.				CO3
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
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				

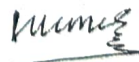
Mapping of COs and POs

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	-

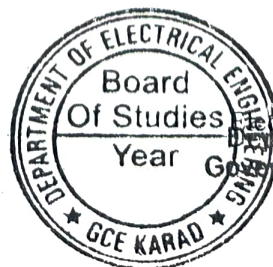
1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

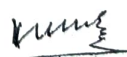
Assessment Pattern (with revised Bloom's Taxonomy)




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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 - 3 rd edition-feb 2013						
Reference links						
1. https://www.carbodydesign.com/						
2. https://www.team-bhp.com/						
3. https://autoprotoaway.com/automotive-design-process/						
4. https://www.carbodydesign.com/						

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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

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

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
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
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
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
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
Unit 5	Management of Charging Networks Charging Network Management - Predictive maintenance and performance optimization - Customer Experience and User Interface				CO3 CO4
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
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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 Mechanical Engineering Dept.
 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	PO10	PO11	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 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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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


Chairman BoS
 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

[Signature]

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

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	03 Hrs/week	MSE		20		
Tutorials	--	ISE		20		
Total Credits	03	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					

	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

Government College of Engineering, Karad			
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	03 Hrs/week	MSE	20
Tutorials	--	ISE	20
Total Credits	03	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)

	- Practical Simulation Examples - Vehicle dynamics simulation for different driving cycles in MATLAB/Simulink - System-level performance validation using simulation tools		
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.	"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	3	1	3	1	—	—	—	—	2	2	2	3
CO 2	3	3	2	2	2	2	—	—	—	—	1	1	3	3
CO 3	3	2	3	1	2	1	—	1	—	—	1	2	3	2
CO 4	2	3	2	2	3	1	—	—	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