Multi-disciplinary Minor (Institute Level-Industrial)

Stream/Technology	Sr. No.	Course category	Course code & Title	Semester
Electrical Vehicle (Electrical perspective Institute Level-Industrial)	1	Multi-disciplinary Minor - 01	IMI3311: Foundation of EV and Hybrid Vehicle	III
	2	Multi-disciplinary Minor – 02	IMI3412: EV Battery Technology and Powertrain Development	IV
	3	Multi-disciplinary Minor – 03	IMI3513: EV Charging Infrastructure & Guidelines	V
	4	Multi-disciplinary Minor Lab – 03	IMI3514: Electric Vehicle Lab	V
	5	Multi-disciplinary Minor – 04	IMI3615: EV Power Electronics and Embedded System	VI
	6	Multi-disciplinary Minor – 05	IMI3716: EV Vehicle Design & Analysis	VII
	7	Multi-disciplinary Minor - 06	IMI3817: EV PCB Design & Data Analytics	VIII

BoS Chairman

Electrical Engineering Department

Government College of Engineering, Karad				
Third Year (Sem – V) B. Tech. Electrical				
IMI3513: EV Charging Infrastructure & Guidelines				
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

BoS Chairman

Electrical Engineering Department

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

BoS Chairman

Electrical Engineering Department

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	1	3
CO3	1	2	3	3	3	-	1	-	2	-	2	2	3
CO4	1	2	3	3	3	-	1	-	2	-	2	2	3

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

BoS Chairman

Electrical Engineering Department

Government College of Engineering, Karad				
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, Flex Ray.	**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
4.	L. Ashok Kumar, S. Albert Alexander, "Power Converters for Electric Vehicles", CRC Press, Taylor & Francis Group, 2021

BoS Chairman

Electrical Engineering Department

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	-	-
CO 2	2	1	2	-	-	1	-	-	-	-	2	-	-
CO 3	2	2	2	-	3	1	-	-	-	-	2	1	2
CO 4	2	2	2	-	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	5	5	10
Apply	5	5	20
Analyse	5	5	25
Evaluate	5	5	5
Create	-	-	-
TOTAL	20	20	60

BoS Chairman

Electrical Engineering Department