



GUJARAT TECHNOLOGICAL UNIVERSITY

Minor Degree: Electric Vehicles

Subject Code: 115AL01

Semester – V

Subject Name: Power Electronics for Electrical Vehicle

Type of course:

Prerequisite: Electrical Machines, basic Power Electronics Devices: Circuits and Applications

Rationale: The use of Power electronics will play important role in making highly efficient electric vehicles having low pollution and better fuel economy. This subject will be helpful to enhance the knowledge of Power Electronics used in up-coming electrical vehicle technology.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	2	4	70	0	30	0	150

Content:

Sr. No	Content	Total Hrs	Weightage
1	Introduction: Electric and Hybrid Electric Vehicles, Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption. Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.	6	16
2	Power Electronics and Automotive Semiconductor Devices: Introduction, Power Electronics System – Its Building Blocks and Components. Construction, Working and Characteristics of Power Devices: Power Diodes, Metal Oxide Semiconductor Field Effect transistors (MOSFET), SIC MOSFET and GaN MOSFET, Insulated Gate Bipolar Transistors (IGBTs), Advance Material used for Power Devices.	8	16
3	Electric motor drive train application in EV: Induction motor drive application in EV, Switched Reluctance motor drive application in EV, BLDC/PMSM drive application in EV, Types of Electric motors & their suitability to EV application, Configuration of Electric Vehicle based on Electric drive train	6	14



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4	Automotive Power Electronics Converters: -DC-DC Converters- Chopper Basics, Types, Buck, Boost, and Buck-Boost Converter Commonalities, Principle of operation, Quadrant operation -AC-DC Converters- Diode uncontrolled Rectifiers, Types, working with different types of loads. Thyristor controlled Rectifiers, Types, working with different types of loads. -DC-AC inverters- Single phase and Three phase configuration, Voltage source Inverter and Current Source Inverter, Multilevel inverter. Working operation with different type of Loads.	12	30
5	Electric Vehicle Charging system: Battery Types, Battery charging basics, Charging control methods, Charging technologies for light electric vehicle, AC and DC charging system, Power Electronic converter for EV battery charger, Fuel Cell, Ultra Capacitor	6	14
6	Battery Management System: Introduction to battery management system, BMS classification based on features and topology, Distributed BMS, Centralized BMS, Charge balancing requirement of batteries, Passive cell Balancing, Active cell Balancing, State of Charge (SoC) Estimation, Battery state of Health (SoH), Battery Depth of Discharge,	4	10

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	30	15	15	10	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

1. Remembering: Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
2. Understanding: Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
3. Applying: Carrying out or using a procedure for executing or implementing.
4. Analyzing: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.
5. Evaluating: Making judgments based on criteria and standards through checking and critiquing.



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6. Creating: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books/Material:

1	M. Ehsani, Y. Gao, S. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2005
2	Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003
3	Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013
4	C. C. Chan and K.T. Chau, "Modern Electric Vehicle Technology", OXFORD University Press.
5	Ali Emadi, "Advanced Electric Drives Vehicles", CRC Press, 2014.

Course Outcomes:

At the end of the course, student should be able to:

Sr. No.	CO statement	Topics Mapped	Marks % weightage
CO-1	Discuss the configuration and performance of Electric & hybrid vehicles.	1, 2, 3, 4	35%
CO-2	Select appropriate Motor drive systems for electrical and hybrid vehicle.	3, 4	30%
CO-3	Choose proper energy storage systems with its charging topology for electrical and hybrid vehicle applications.	5	20%
CO-4	Discuss energy storage devices and its management system for hybrid and electrical vehicle.	6	15%

Suggested List of Experiments:

1	To study basics of Electric and Hybrid Electric Vehicles and their performance.
2	To study Series and Parallel hybrid electric drive trains.
3	To study role of Permanent Magnet Motor Drives in Electric Vehicle.
4	To study Switched Reluctant Motor Drive for Electric Vehicles.
5	To study regenerative braking of AC & DC motors in electric drive.
6	To study AC-DC converter operation with motor load.
7	To study DC-AC converter operation with induction motor.
8	To study AC-AC converter operation for motor load.
9	To study chopper based drive system.
10	To study Control strategies of parallel hybrid drive train.
11	To study Energy storage requirements and Battery parameters in EV.
12	To study energy management strategies used in hybrid and electric vehicles



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Software/Major Equipment:

Open source software, CRO/DSO, Multi-meters, volt/current meters, Breadboard, necessary components etc.