GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Power Electronics Engineering

Subject Code: DI04024071

Subject Name: Electric Vehicle

w. e. f. Academic Year:	2025-26
Semester:	4th
Category of the Course:	Professional Elective - II

Prerequisite:	Classification of Electric motor with their working principle, classification of power electronics converter, working principle of power electronics switches.
Rationale:	Electric Vehicles (EVs) are emerging as a sustainable alternative to conventional vehicles, offering high efficiency and reduced environmental impact. For Power Electronics students, EVs present a vital area of application involving power converters, motor control, and battery management systems. This subject develops the ability to analyze, and implement power electronic systems used in electric vehicles, preparing students for careers in electric mobility and related industries.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Identify and select suitable electric vehicle architectures and components for specific applications.	R, U
02	Apply the principles of electric drives to control various types of motors used in electric vehicles.	R, U, A
03	Operate and maintain power electronic converter circuits for motor control in EVs.	R, U, A
04	Test and evaluate the performance of battery systems and apply BMS techniques for energy management and safety.	R, U, A
05	Test charging system used for EVs.	R, U, A

**Revised Bloom's Taxonomy (RBT)*

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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE(E)	PA(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Electric and Hybrid Vehicles** Concept and need for electric mobility, EV and HEV: History Comparison between IC engine vehicles and EVs Classification and comparison of BEV and HEV. Basic BEV architecture and components overview. Various HEV architecture with comparison advantages and disadvantages. Recent development in BEV and HEV.	8	18
2.	**Electric Propulsion and Drive Systems** Principle of electric propulsion, Types of electric motors used in EVs with construction, Speed-torque characteristics, ratings and Comparison. Classification of control methods of motors used in EVs. Concept of Regenerative braking in EV.	8	18
3.	**Power Electronic Converters and Controllers for EV** Role of power electronics in EVs. DC–DC converters: Buck, Boost, Buck-boost, Bidirectional converters DC–AC inverters: Six step voltage source inverter, PWM control. Protection and interfacing circuits. Basics of BLDC Motor Control for Electric Vehicles Basics of SRM Motor Control for Electric Vehicles	11	24
4.	**Energy Storage system** Battery Working principle, classification, Various Battery parameters. Structure and characteristics of Lead acid, Lithium Ion, Lithium Polymer and lithium iron phosphate, NiMH battery. Battery Management System (BMS) architecture, SOC (State of Charge) and SOH (State of Health) monitoring, Thermal management and protection circuits.	12	26

	Fuel cell Working principle, Basic structure, types, comparison, Codes and standards of hydrogen. Fuel Cell Electric Vehicles: structure, advantages-disadvantages and recent trends.		
5.	**EV Charging Systems and Infrastructure** Basics of EV Charging, Types of EV Chargers: AC & DC with ratings, EV charging methods: slow, fast, and rapid charging**,** On-board and off-board chargers**,** Wireless charging principles**,** Charging station layout, requirements and safety features**,** Battery Swapping and Quick Charging Technologies, Introduction to standards and communication protocols (IEC, CHAdeMO, CCS)	6	14
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
30	**60**	**10**			

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:
(a) Books:

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Electric and Hybrid Vehicles Design Fundamentals	Iqbal Husain	CRC Press ISBN: 978-1-138-59058-8
2	Advance Electric Drive Vehicles	Ali Emadi	CRC Press ISBN: 978-1-4665-9770-9
3	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	Mehrdad Ehsani Yimin Gao Stefano Longo Kambiz Ebrahimi	CRC Press ISBN: 978-1-4987-6177-2
4	Handbook of Electric vehicle Charging Infrastructure Implementation	--	NITI Ayog

S. No.	Title of Book	Author	Publication with place, year and ISBN
5	Electric vehicle Technology Explained	James Larminie, John Lowry	WILEY ISBN: 9781119942733

(b) Open-source software and website:

NPTEL / AICTE EV training modules.
www.vlab.co.in
www.youtube.com

Suggested Course Practical List:

S. No.	Suggested Course Practical
1.	Study Battery Electric Vehicle (BEV) architecture with block diagram.
2.	Study Hybrid Electric Vehicle (HEV) architecture with different configuration.
3.	Comparative Study of IC Engine Vehicle, Battery Electric Vehicle and Hybrid Electric Vehicle
4.	Test the performance of fuel cell.
5.	Case Study on Recent Developments in Electric and Hybrid Vehicles.
6.	Identify and test various parts of BLDC motor used for EVs.
7.	Identify and test various parts of PMSM motor used for EVs.
8.	Identify and test various parts of SRM motor used for EVs.
9.	Identify and test various parts of Induction Motor used for EVs.
10.	Comparative Study of Electric Motors used for EVs.
11.	Study of Regenerative charging and braking phenomenon of EV.
12.	Study load characteristics of BLDC motor
13.	Study N-T characteristics of BLDC motor
14.	Study speed control of BLDC motor using PWM control.
15.	Study Running, Reversing and Braking of BLDC motor.
16.	Study the controller and its output of Electric vehicle.
17.	Obtain no load parameters of Electric vehicle.
18.	Obtain with load parameter of Electric vehicle.
19.	Study fault analysis of BLDC motor used for electric vehicle
20.	Study battery management system and measure voltage across each battery.
21.	Study charging and discharging characteristics of BMS
22.	Study cell balancing phenomenon of BMS.

S. No.	Suggested Course Practical
23.	Study charging and discharging characteristics of Lead acid Battery
24.	Study charging and discharging characteristics of Lithium Ion Battery
25.	Study charging and discharging characteristics of Lithium Polymer Battery
26.	Study charging and discharging characteristics of Lithium Iron Phosphate Battery
27.	Test the performance of 6 step 3-phase 120° mode inverter.
28.	Test the performance of 6 step 3-phase 180° mode inverter.
29.	Test the performance of 3-phase sinusoidal PWM inverter.
30.	Study of AC and DC Chargers of EV.
31.	Demonstration of Slow, Fast, and Rapid Charging methods for EV.
32.	Study of EV Charging Station Layout and Components
33.	Study of Safety Features in EV Charging Infrastructure

List of Laboratory/Learning Resources Required:

S. No.	Equipment Name with Broad Specifications
1	MATLAB software student version
2	Battery characteristics trainer for various batteries used in EVs.
3	BLDC (Brushless DC) Motor Training System: Mains Supply: Single Phase, 230V ±10%, 50Hz Machine Type: BLDC Rating: 200W Voltage Rating: 24V Current: 8 Amp. Speed: 2500 rpm ±10% Loading arrangement: Mechanical Brake Drum/Pulley: Aluminium casted Instrumentation power supply: 24V, 10Amp. Digital Meters used DC Voltmeter: 300V DC Ammeter: 10A Digital Tachometer: 20,000 rpm
4	Battery Management Training System: Mains Supply: Single Phase, 230V ±10%, 50Hz Battery pack Type: Li-ion No of Cell: 6 N, Power rating: 3000 mAh, Configuration: Series type Machine (for charging & discharging battery pack) Type: BLDC Rating: 100-Watt. Voltage Rating: 24V Current: 3 Amp. approx. (at no load) Speed: 2800 rpm ±10% Instrumentation power supply: 24V, 10Amp. Graphical LCD: For Voltage, Current and Temperature measurements Digital Meters used DC Voltmeter: 300V DC Ammeter: 10A Digital Tachometer: 20,000 rpm
5	Electric Vehicle Training System BLDC Motor Type of Motor: Hub motor Rated Voltage: 36V Power: 250W RPM: 200 RPM approx. (on full load) Battery Type of battery: Li-ion battery Capacity: 10 AH Voltage: 36V Meters • AC Voltmeter • AC Ammeter • DC Voltmeter • DC Ammeter • RPM meter Package contains Key switch, Head light, Tail light, Brake, Horn and Battery level indicator

S. No.	Equipment Name with Broad Specifications
6	Regenerative charging & Braking Training system.
7	Switched Reluctance Motor Drive The kit comprises of power module, 0.5 HP, 3000rpm SRM motor, 500ppr encoder and 32-bit ARM Microcontroller based digital control circuit. Microcontroller based control circuit with LCD and keyboard interface Open loop and closed loop speed control of motor. 230 V, 50 Hz, AC supply. Proper isolation between control and power circuit is provided. Motor Controller: STM32F407VGT6 ARM Cortex LCD interface, 5 keys interface. 3 high speed digital outputs and 2 High speed digital input lines. 6 PWM outputs.
8	Hydrogen Fuel Cell Experiment kit
9	EV Charger simulator kit

Suggested Project List:

- Poster / Presentation on Evolution of Electric Mobility
- Models/ Poster of various Hybrid EV Architecture.
- Case Study on Indian EV Market Growth.
- Model of Regenerative Braking System
- Poster of Comparative Study of EV Motors
- Build or simulate a 12V–48V buck converter.
- Arduino-based BMS to monitor voltage, current, and temperature.
- Prepare report and chart comparing connector types and protocols.
- Design layout diagram showing isolation, control, and safety devices for EV charging station.

Suggested Activities for Students:

- Make a Poster or Presentation on “Evolution of Electric Mobility in India.”
- Identify and Present Major EV Manufacturers (Tata, Mahindra, TVS, Bajaj, Ola, Tesla, BYD, etc.) and their models.
- Organize a Group Discussion on “EVs replacement of petrol/Diesel vehicles in India”

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