GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Electrical Engineering / Renewable Energy

Subject Code: DI05000221

Subject Name: Electrical Vehicle Technology

w. e. f. Academic Year:	2026 - 27
Semester:	5th
Category of the Course:	MOPEC

Prerequisite:	Basic knowledge of electrical machines, power electronics, and electrical measurements.
Rationale:	This course introduces the fundamentals of electric vehicle technology, including vehicle dynamics, propulsion systems, battery technology, and charging infrastructure. It enables students to understand the operation and performance of EV systems with focus on practical applications. The course also incorporates EV charging standards and government policies to provide industry-relevant knowledge, preparing diploma students for opportunities in the electric mobility sector.

Course Outcomes: After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level*
01	Explain types, architecture, power flow and vehicle dynamics of electric vehicles	R, U
02	Describe electric propulsion systems including motors, drives and basic power electronic applications	U
03	Apply battery concepts, parameters and calculations for energy storage and driving range estimation	U,A
04	Explain EV charging systems, infrastructure and relevant policies in India	U

**Revised Bloom's Taxonomy (RBT)*

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)	
2	0	2	3	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Unit 1: Introduction to Electric Vehicles and Vehicle Dynamics** • Evolution and need of electric vehicles • Limitations of IC engine vehicles and advantages of EVs • Types of electric vehicles: BEV, HEV, PHEV, FCEV: Definition, Example • Basic architecture of EV: Block diagram and components (Battery, Controller, Motor, Drivetrain) • Power flow in electric vehicles: BEV (battery to motor), HEV (engine + battery combined operation), PHEV (hybrid with external charging) • Comparison of EV and IC engine vehicles • EV economics: Total Cost of Ownership (TCO), Payback period (numerical) • Drive cycle: Definition and purpose, Types (urban, highway – basic idea), Importance in EV performance evaluation • Vehicle dynamics basics: Rolling resistance, Aerodynamic drag, Gradient (hill climbing) force • Numerical problems: Estimation of tractive force and power required for vehicle motion	7	23%
2	**Unit 2: Electric Propulsion System (Motor, Drive and Power Electronics)** • Requirements of EV motors: High torque, High efficiency, Minimal maintenance • Types of Motors used in EV: BLDC Motor: Construction, working,	8	27%

	Advantages, PMSM & Induction Motor: Working, Advantages, Comparisons • Torque-speed characteristics of motors used in EV • Motor drives and controllers: Role of inverters in EV, Basic Speed control concept, Basic block diagram of EV drive system, Role of DC-DC converters in EV systems (concept only), PWM concept for voltage and speed control • Regenerative braking in EV: Numerical on regenerative braking		
3	**Unit 3: Battery Technology and Energy Storage Systems** • Battery basics: Voltage, current, capacity, energy • Battery parameters: State of Charge (SoC), Depth of Discharge (DoD), C-rate, State of Health (SoH) • Types of batteries: Lead-acid, NiMH, Lithium-ion, Lithium-ion working principle • Hybrid energy storage system: Battery and ultra-capacitor, Comparison (energy density vs power density) • Battery pack design: Series and parallel configuration • Battery calculations: Ah, Wh calculation, Driving range estimation (Wh/km method) Simple numerical problems • Fuel cell basics: Working principle and application in EV • Battery Management System (BMS): Functions, protection, balancing, thermal management	9	30%
4	**Unit 4: EV Charging Systems, Infrastructure and Policies** • Types of Charging systems: AC charging (slow and moderate charging: Level 1 and Level 2), DC charging (fast charging – Level 3), Comparison of AC and DC charging, On-board and Off-board Chargers: Definition and working & Comparison • Charging Methods: Constant Current (CC), Constant Voltage (CV), CC–CV method (basic concept) • Charging Standards: Type 2, CCS (Combined Charging System), Bharat EV • Basic Charging Infrastructure: Public charging, Private charging, Charging station concept • EV policies (India): FAME scheme (basic concept), State EV	6	20%

	policies (overview)		
		30	**100%**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
10 %	40 %	50 %	00	00	00

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) Reference Books:

1. Electric and Hybrid Electric Vehicles – Iqbal Husain
2. Electric Vehicle Technology Explained – Larminie& Lowry
3. Modern Electric, Hybrid Electric Vehicles – Mehrdad Ehsani
4. Advanced Electric Drive Vehicles – Ali Emadi
5. Electric Powertrain – Hayes & Goodarzi
6. Build Your Own Electric Vehicle – Seth Leitman
7. Fundamentals of Electric Vehicles – NPTEL Notes
8. Battery Management Systems – Gregory L. Plett
9. Power Electronics – P.S. Bimbhra

(b) Open-Source Software and Website:

Topic	Resource Type	Link
EV Basics	Tutorial	https://nptel.ac.in
EV Fundamentals	Video	https://youtu.be/tJfERzrG-D8?si=5hmqrWIFCwvmAhe9
How Electric Cars Work?	Video	https://youtu.be/kzsyJROQOas?si=EyDkRGIJXts2oc3n https://youtu.be/td5Z4wiwhDU?si=C6b_IPKQwq7xTZAh

Types of electric vehicles with examples	Video	https://youtu.be/qxmhFRx2fOw?si=eVKY5C4bUQMRi37z
Vehicle Dynamics	Video	https://youtu.be/7YShjrDwP9s?si=pfVOaEcwrGxiHpMR
Types of Motors used in EV	Video	https://youtu.be/6H5vtu5_SF4?si=gcy5HlW6nl1bzMqM
EV Simulation	Software	MATLAB Simulink
Virtual Labs	Simulation	https://iitb.vlabs.co.in/
EV Policy & Data	Portal	https://niti.gov.in
Electric Vehicle Powertrain Components	Video	https://youtu.be/HfN5dEeUyuE?si=WwhqBAI_kL-7ju5e
Battery Basics	Educational	https://batteryuniversity.com
Battery Management Systems	Video	https://youtu.be/k1N2LyXtK-k?si=Te8asFQWMhbOG0sN
EV Charging Systems	Video	https://youtu.be/iRmtLbGZoQs?si=V3j5Fg7wD5ATqZ5b
EV CHARGER TOPOLOGIES	Video	https://youtu.be/T_Lc75bn9hg?si=5RTFID87RTenJVLt

Suggested Course Practical List: Each week includes one lab sessions (2 hours), designed such that they complement theory topics, means each experiment directly supports the classroom teaching.

Sr. No.	Practical Outcome/Title of experiment	Unit/ CO	Approx. Hours
1	Study and identification of EV components (battery, motor, controller, drivetrain) using charts/models	CO1	2

2	Numerical exercise on estimation of tractive force and power required for vehicle motion	CO1	2
3	Simulation on estimate tractive force and power required for electric vehicle motion (Any simulation software)	CO1	4
4	Demonstration of PWM technique for motor speed control	CO2	4
5	Measurement of battery voltage, current and estimation of capacity	CO3	2
6	Charge and discharge characteristics of battery and estimation of SoC	CO3	4
7	Design of battery pack for given EV specification (series-parallel calculation)	CO3	2
8	Simulation on EV battery pack, estimate driving range and charging time (Any simulation software)	CO3	4
9	Estimation of EV driving range using Wh/km method	CO3	2
10	Simulation on EV driving range using Wh/km method (Any simulation software)	CO3	4
11	Simulation on estimate battery charging time and state of charge (Any simulation software)	CO3	2
12	Study of EV charging systems & standards.	CO4	2
13	Calculation of EV charging time and energy consumption for different battery and charger ratings	CO4	4

Subject In-charge can add performance practical only.

List of Laboratory/Learning Resources Required:

Category	**Equipment / Tool**	**Specifications / Notes**
A. Measuring Instruments	Clamp-on Digital Power Meter	AC/DC, true RMS

	Digital Wattmeter & Multimeter	Standard lab usage
B. Electrical Machines & Systems	Induction Motors	Single-phase & three-phase, 0.5–5 HP range
	BLDC Motor Kit	Demonstration purpose
C. Battery and Energy Storage	Rechargeable Batteries	Lead-acid / Lithium-ion (demo units), Low voltage (12V/24V)
	Battery Charging Unit	CC-CV type charger
	DC Power Supply	Variable (0–30V typical)
D. Power Electronics	DC-DC Converter Trainer Kit	Buck and Boost converter
	Inverter Trainer Kit	Single-phase inverter
	PWM Generation Kit	PWM control demonstration
	CRO / DSO	Waveform observation
E. EV Charging and Infrastructure (Demonstration Level)	EV Charger Demo Unit	AC charger (Level 1/Level 2 model)
	Charging Connectors	Type 2 / Bharat EV (dummy models)
	EV Charging Station Model	Layout or mini prototype
	Energy Meter	For charging energy measurement, single phase
F. General Teaching Aids	EV System Charts	Block diagrams and component visuals
	Cut-section Models	Motor / battery models-Demonstration
	Computer System with Internet	For virtual labs and videos

Suggested Activities for Students:

To enhance the learning outcomes of the "Electrical Vehicle Technology" course, students are encouraged to participate in co-curricular activities that provide practical exposure to electric vehicle systems, battery technology, charging infrastructure, and performance evaluation. These activities help in understanding EV components, energy management, and real-world applications of electric mobility.

- Compare EV and IC engine vehicles based on efficiency and cost
- Study EV models available in India (case study)

- Analyze battery capacity vs range
- Visit EV charging station or workshop
- Prepare EV subsystem block diagram
- Study EV policies (FAME, state policies)

Suggested Project List: Suggested Project List as given below:

Individual Projects:

- Battery pack design for electric scooter
- EV charging time and cost analysis
- Comparison of EV vs petrol vehicle

Group Projects

- Simulation of EV motor drive system
- Design of basic EV charging station layout
- EV energy consumption analysis

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