GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Automobile Engineering

Subject Code: DI05002031

Subject Name: Advance Automotive Technology

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

Prerequisite:	---
Rationale:	The automotive industry is rapidly evolving with the adoption of electrification, advanced control systems, connectivity, and autonomous technologies. This course is designed to provide students with a comprehensive understanding of electric and hybrid vehicles, including their powertrain architectures, electric drive systems, battery technologies, and charging infrastructure. It further covers advanced vehicle dynamics and chassis control systems to build a strong foundation in modern vehicle control. The course also introduces autonomous and connected vehicle technologies such as ADAS, sensor integration, artificial intelligence, and vehicle communication systems. Overall, the syllabus ensures a balanced blend of fundamental concepts and emerging technologies, preparing students to meet current industry requirements and future mobility challenges.

Course Outcome:

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

No	Course Outcomes	RBT Level
01	Explain the concepts, types, configurations, and working principles of electric and hybrid electric vehicles along with their benefits, challenges, and safety practices.	R, U & A
02	Understand the working principles of electric motors, motor controllers, power converters, and sensors used in electric and hybrid vehicles.	R & U
03	Analyse battery technologies, battery management systems, charging methods, and energy management strategies used in electric vehicles.	R, U & A
04	Apply the concepts of advanced chassis systems including brake-by-wire, steer-by-wire, suspension systems, and automotive actuators in vehicle control.	U & A
05	Analyze ADAS, autonomous driving technologies, sensor systems, vehicle communication, and cybersecurity aspects in modern vehicles.	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.	**Fundamentals of Electric and Hybrid electric vehicles** 1.1 Introduction to electric and hybrid electric vehicles 1.2 Powertrain - Systems of Battery Electric Vehicles (BEVs) and Hybrid Electric Vehicle (HEVs) 1.3 Electric Vehicle types and its configurations 1.4 Hybrid levels and its powertrain configurations 1.5 Combustion engines and electric motors integration in Hybrid Vehicles; Engine-motor coupling mechanisms, Starter-generators, Integrated motor-generators 1.6 Electric Vehicle & Hybrid Vehicle Transmissions and Transaxles: Single/Multi-Speed EV Transmissions, e-CVTs and Hybrid DCTs 1.7 Benefits and challenges of electric and hybrid electric vehicles: Environmental Benefits (Reduced Emissions), Economic Benefits (Lower Operating Costs), Performance Advantages, Range Limitations, Charging Infrastructure Challenges, Battery Technology Constraints 1.8 Safety precautions and procedures of Electric and Hybrid Vehicles. 1.9 Maintenance and diagnostics of electric powertrain components. • Various tools required for EV/Hybrid Vehicle components testing. • Inspect, remove and replace procedure of high voltage & low voltage components	10 hrs	20%
2.	**Motors and control systems of electric and hybrid electric vehicles.** 2.1 Types, construction and functions of electric vehicle motors • Brushless DC motor • Permanent magnet synchronous motor (PMSM) • Three phase AC induction motor 2.2 Control Systems: • Importance of motor controller in electric and hybrid electric vehicles • Basic operation of control systems • Types of motor controllers; Variable resistor type controller & Pulse width modulation	6 hrs	15%

	• Sensors in control systems 2.3 Converters & inverters		
3.	**Battery technologies & charging infrastructure** Battery Technologies: 3.1 Introduction to Battery Basics: Range, Life, Recycling Charging state & Health 3.2 Types of Batteries: Lead-Acid, Alkaline, Sodium-Nickel Chloride, Sodium-Sulphur, Lithium-ion 3.3 Battery Developments: Temperature management, Fast Charging Batteries, Solid State Batteries 3.4 Battery - cell balancing & Component cooling in control systems 3.5 Battery Management system (BMS) 3.6 Battery maintenance and disposal procedure and techniques. 3.7 High voltage safety precautions; Personal Protective Equipment (PPE), High-energy cables and components, AC & DC electric shocks Charging infrastructure and energy management: 3.8 EV's Charging technologies and standards (AC, DC, fast charging). 3.9 EV's Charging station infrastructure and deployment. • Overview of electric vehicle charging • Types of charging stations: Level 1, Level 2, DC Fast Charging • Public charging networks and stations • Components of a charging station: Chargers, Connectors, Communication Protocols • Charging station operation and protocols • Safety measures and standards in charging infrastructure 3.11 Smart grid integration and Swap-able battery charging station. 3.12 Energy management system. 3.13 Supercapacitors & Electric Flywheels	10 hrs	25%
4.	**Advanced Vehicle Dynamics and Chassis Control Systems** 4.1 Brake-by-Wire and Regenerative Braking Systems 4.2 Steering Systems: • Steer-by-Wire & Electronic Power Steering (EPS) • Adaptive and Active Steering Systems • Torque Vectoring • Haptic Steering 4.3 Electronically Controlled Suspension Systems: • Semi-active Suspension • Active (Pro-active) Suspension Systems 4.4 Advanced Suspension Technologies: • Magneto-Rheological (MR) Fluid Suspension	9 hrs.	20%

	• Hydro-elastic Suspension 4.5 Actuation Systems for Vehicle Dynamics Control: • Hydraulic Actuators • Electromechanical Actuators • Role in Active Body Control 4.6 Advanced Automotive Actuators: Construction and Working • Solenoid Actuators • Motorized Actuators • Stepper Motors • Synchronous Motors • Thermal Actuators 4.7 Advanced materials used in automotive manufacturing: • Importance of weight reduction in vehicles • Materials like: High-strength (Press Hardened & Nano-structured) steel, High-Formability Aluminium, Magnesium alloys & Carbon Fiber composites. • Design optimization for fuel efficiency & impact of lightweight materials on vehicle performance and safety		
5.	**Autonomous, Connected and Intelligent Vehicle Systems** **Advanced Driver Assistance Systems (ADAS):** 5.1 Overview and Working of ADAS Technologies: • Adaptive Cruise Control (ACC) • Automatic Emergency Braking (AEB) • Lane Departure Warning System (LDWS) • Blind Spot Detection 5.2 Sensors used in ADAS: Radar, LiDAR, Ultrasonic Sensors, Camera Systems 5.3 Sensor Integration and Vehicle Control Systems 5.4 Pre-crash and Safety Systems: • Collision Warning Systems • Frontal and Rear Object Detection • Object Detection with Braking Interaction • Hill Assist Systems • Occupant Detection Systems • Rear Detection Systems **Autonomous and Connected Vehicles:** 5.5 Concept of Autonomous Driving 5.6 Levels of Vehicle Automation (Level 0 to Level 5)	10 hrs	20%

	5.7 Core Technologies in Autonomous Vehicles: Artificial Intelligence, Machine Learning & Computer Vision 5.8 Communication Technologies: • Vehicle-to-Vehicle (V2V) • Vehicle-to-Infrastructure (V2I) • Vehicle-to-Everything (V2X) 5.9 AI-Based Smart Cockpit Systems 5.10 Over-the-Air (OTA) Updates 5.11 Vehicle Cybersecurity 5.12 540° Camera and Surround View Systems 5.13 Challenges in Autonomous Vehicle Deployment 5.14 Legal, Ethical and Safety Considerations		
	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	**30**	**40**	**-**	**-**	**-**

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 Electric vehicles.	James Halderman and Curt ward	Pearson Education, Inc., ISBN 10: 0-13-753212-1 ISBN 13: 978-0-13-753212-4
2	Electric and Hybrid Electric vehicles.	Tom Denton and Hayley Pells	Routledge India, New Delhi, 2020 ISBN 9781032556802
3	A Fundamentals of Hybrid and Electric Vehicles	K.C. Jain, Amit R. Patil, A.J. Bhosale, S.S. Raghuvanshi	Khanna Publishing, New Delhi, 2024, ISBN: 9789392549762
4	Electric and Hybrid Vehicle (Green & Sustainable Transportation)	Dr. Nitesh Tiwari, Dr. Shekhar Yadav	S.K. Kataria & Sons, New Delhi, 2023, ISBN: 9788196358907

5	Electric Vehicle Design & Applications (Indian Contributors)	Applications (Indian Contributors) K. Arora et al.	Wiley India, New Delhi, 2024, ISBN: 9781394204373
6	A Text Book of Hybrid Electric Vehicles	S. Vijaya Kumar et al.	IIP Publications, India, 2023, ISBN: 9789357472937
7	Advances in Automotive Technologies (Proceedings of ICPAT)	M. Razi Nalim, R. Vasudevan, S. Rahatekar (Eds.)	Springer India, New Delhi, 2021, ISBN: 9789811559464
8	Advanced Automotive Fault Diagnosis	Tom Denton	Routledge India, New Delhi, 2020, ISBN: 9780367330521
9	A Textbook of Automobile Engineering (with Advanced Topics)	S.K. Gupta	S. Chand Publishing, New Delhi, 2020, ISBN: 9789352838165

(b) Open-source software and website:

1. https://swayam.gov.in
2. https://vlab.co.in
3. https://nptel.ac.in
4. https://www.youtube.com/c/WeberAuto
5. https://x-engineer.org
6. https://batteryuniversity.com
7. https://nptel.ac.in
8. https://online-learning.tudelft.nl
9. https://afdc.energy.gov
10. https://carla.org
11. https://www.lesics.com
12. https://ocw.mit.edu
13. https://www.bosch-mobility.com

Suggested Course Practical List:

Sr. No	Practical Outcomes (PrOs)		Unit No.	Approx. Hrs. required
1	Identify various parts/ components of Battery Electric Vehicles & Hybrid Electric Vehicles (PHEVs)	Any one	1	2
2	Identify various parts/ components in between Series hybrids, Parallel hybrids and Series-parallel hybrids		1	2

3	Draw power flow line diagram in Parallel hybrid transmissions & Power-split hybrid transmissions	Any one	1	4
4	Examine, Remove and Replace Procedure of Electric Vehicle Components		1	4
5	Identify different diagnostic and maintenance tools of EV and Hybrid Vehicles.		1	4
6	Identify different components of EV and Hybrid Vehicle Motors.	Any one	2	4
7	Check controlling system of different EV motors		2	4
8	Describe different types of Battery Cooling System or Technologies.	Any two	3	4
9	Describe Battery Management System in electric Vehicles.		3	4
10	Understand Safety measures and standards in charging infrastructure.		3	4
11	Compare and understand the operation of different Charging stations		3	4
12	Identify and compare advanced materials (HSS, Aluminium, Magnesium, Carbon fibre)	Any one	4	4
13	Observe and understand Advanced chassis control systems.		4	4
14	Observe different Actuators used in Automobiles.		4	4
15	Observe vehicle comfort and safety systems (collision warning, hill assist, sensors)	Any one	5	4
16	Demonstrate working of ADAS sensors (Radar, LiDAR, Camera, Ultrasonic)		5	4
17	Demonstrate Smart Cockpit, OTA updates, and Vehicle Cybersecurity	Any one	5	4
18	Understand V2V, V2I, and V2X communication systems		5	4
	Total Hrs.	**8**		**30**

List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	EV/Hybrid Powertrain Demonstrator: Cut-section or physical model showing the integration of motor, battery, and transaxle.	1,2,3,4,8
2	High Voltage Safety Kit: Standard PPE including Class 0 insulated gloves, safety visors, and insulated floor mats.	4,5.10

3	Electric Motor Training Bench: Setup featuring BLDC and PMSM motors with programmable controllers and dynamometers.	6,7
4	Battery Management System (BMS) Trainer: Educational kit demonstrating cell balancing, thermal monitoring, and overcharge protection.	9.11
5	EV Charging Simulator: Level 1/Level 2 wall-box charger model with standard connectors (CCS, CHAdeMO) and protocol demonstration.	12
6	Advanced Materials Sample Kit: Physical samples of press-hardened steel, carbon fibre composites, and magnesium alloys.	13
7	Automotive Actuator & Steering Rig: Test bench featuring Steer-by-Wire components, solenoids, and stepper motors.	14,15
8	ADAS Sensor Training Kit: Setup featuring ultrasonic sensors, basic camera modules, and radar/LiDAR simulation interfaces.	16,17,20
9	Advanced OBD-II Diagnostic Scanners: Capable of reading network codes for both standard older ICE models (e.g., 2016 hatchbacks) and modern EVs.	18
10	Simulation Software Lab: Computers pre-loaded with OpenModelica, Arduino IDE, and CARLA Simulator.	18,19

Suggested Project List:

Basic E-Bicycle Conversion: Converting a standard bicycle to an electric drive using an off-the-shelf hub motor kit.
Ultrasonic Obstacle Detection Model: Building a simple tabletop vehicle that stops automatically when an obstacle is detected using basic ultrasonic sensors.
Battery Level & Temperature Indicator: Creating a basic circuit to monitor the voltage and temperature of a small battery pack.
Regenerative Braking Demonstration Model: Fabricating a small mechanical wheel model that lights up an LED when mechanical braking is applied.
Local EV Charging Station Survey: A field-research project documenting the locations, connector types, and user experiences of public EV chargers in your city.
Automotive Lightweighting Study: Creating a comparative weight and strength analysis report by testing small strips of conventional steel versus aluminium.
Basic Line-Following Robot: Assembling a simple autonomous guided vehicle (AGV) using basic infrared sensors and a microcontroller.
Basic E-Bicycle Conversion: Converting a standard bicycle to an electric drive using an off-the-shelf hub motor kit.
Ultrasonic Obstacle Detection Model: Building a simple tabletop vehicle that stops automatically when an obstacle is detected using basic ultrasonic sensors.

Suggested Activities for Students: If any

Beyond classroom teaching and learning, the following co-curricular activities are recommended to enhance the achievement of learning outcomes in this course. Students are encouraged to undertake these activities individually or in groups. At least one activity from the following should be carried out.:

1. Industrial Visit: Tour a regional automobile manufacturing plant, EV assembly line (e.g., facilities in Sanand or Halol), or an authorized EV service center.
2. Charging Hub Field Trip: Visit a public EV charging station to study smart grid integration, charging protocols, and layout deployment.
3. High-Voltage Safety Workshop: Participate in a hands-on workshop focused strictly on High Voltage (HV) safety procedures and the correct use of PPE.
4. Group Discussion: Debate the ethical, legal, and safety considerations of Level 4 and Level 5 autonomous vehicles in Indian traffic conditions.
5. Open-Source Simulation: Join open-source simulator communities (like the CARLA Ecosystem) to run and observe basic autonomous driving and weather scenarios.
6. Technical Seminar: Prepare and deliver a presentation on emerging trends like solid-state batteries or hydrogen fuel cells.
7. Diagnostic Scanning Practice: Perform hands-on OBD-II scanning to clear fault codes and read live data streams on both conventional and hybrid vehicles.
8. Poster Competition: Design and present technical charts on advanced chassis control systems (e.g., steer-by-wire, active suspension).
9. MOOC Certification: Complete an online NPTEL or Swayam course specifically focused on Battery Management Systems or Automotive Cybersecurity.
10. Scrap Analysis: Identify and analyse the disposal, recycling techniques, and environmental impact of dead lithium-ion battery packs.

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