# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Industry Led Minor/Hons.**
**Level: UG**
**Branch: Electric Vehicles**
**Course / Subject Code : BE04IAT011**
**Course / Subject Name :Fundamentals of Electric Vehicle Systems and Architecture**

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| w. e. f. Academic Year: | 2025-26 |
| Semester: | 4th |
| Category of the Course: | Core Courses |

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| Prerequisite: | Fundamentals of mechanical & electrical engineering. Open to all streams |
| Rationale: | This course introduces learners to the core systems of Electric Vehicles, encompassing technology evolution, electrical architecture, powertrain, and safety standards. By bridging electrical and mechanical fundamentals, it builds the technical understanding required to design, analyze, and simulate EV subsystems—skills directly relevant to careers in automotive engineering, e-mobility, and advanced vehicle technology development. |

**Course Outcome:**

After Completion of the Course, Student will able to:

| No | Course Outcomes | RBT Level* |
|---|---|---|
| 01 | Differentiate electric vehicle configurations from internal combustion engine systems based on technology, performance, and energy efficiency. | U,N |
| 02 | Illustrate the complete architecture and energy flow of an electric vehicle through system-level diagrams or models. | R,A |
| 03 | Apply electrical and electronic principles to analyze EV subsystems such as converters, rectifiers, and control circuits. | A,N |
| 04 | Evaluate the performance and operation of EV powertrain components including motors, drivetrains, and regenerative braking systems. | E |
| 05 | Interpret and implement EV safety standards, testing protocols, and lab safety procedures in simulated or real environments. | U,A,N |
| 06 | Demonstrate integration of key electrical and mechanical elements in an EV system or prototype. | A,C |

**Revised Bloom's Taxonomy (RBT)*

**Teaching and Examination Scheme:**

| Teaching Scheme (in Hours/week) | | | Total Credits L+T+ (PR/2) | Assessment Pattern and Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | Tutorial / Practical | | |
| L | T | PR | C | ESE (E) | PA / CA (M) | PA/CA (I) | ESE (V) | |
| 4 | 0 | 2 | 5 | 100 | 0 | 0 | 0 | 100 |

| | | |
|---|---|---|
| *Total Lecture Hrs. (L) =60 | Total Practical Hrs. (PR) =30. | Total Hours =90Hrs |

**Course Content:**

| Unit No. | Content | No. of Hours | % of Weightage |
|---|---|---|---|
| 1. | Introduction to EV Technology:<br>• Types of EVs: BEV, HEV, PHEV, FCEV<br>• Global & Indian EV Market Overview<br>• Comparison: EV vs ICE (efficiency, emissions, performance, cost) | 10 | 10% |
| 2. | EV Architecture:<br>• Overall EV Block Diagram<br>• • Traction Battery Pack Architecture<br>• Energy Flow from Grid → Battery → Motor | 10 | 15% |
| 3. | Electrical & Electronics Basics:<br>• Basic Electrical Concepts: Voltage, Current, Power, Energy<br>• AC vs DC: Characteristics, Applications in EV<br>• Semiconductors: Diodes, BJTs, MOSFETs, IGBTs<br>• Power Converters: AC-DC, DC-DC, DC-AC | 25 | 25% |
| 4. | EV Powertrain:<br>• Types of Motors: BLDC, PMSM, IM<br>• Regenerative Braking: Concepts, Energy Recovery, Control Strategies | 15 | 20% |
| 5. | Safety & Standards:<br>• ISO 26262,<br>• AIS-038,<br>• PPE & EV lab safety | 15 | 10% |
| 6. | Mini Project: Simple EV subsystem simulation/prototype | 15 | 20% |
| | **Total** | **90** | 100% |

**Suggested Specification Table with Marks:**

| **Distribution of Marks (in %)** | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| **10** | **10** | **15** | **15** | **20** | **30** |

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

| Skill & Practical Activities to be carried out during Semester | | | | | | |
|---|---|---|---|---|---|---|
| **Sr. No.** | **Category of Engagement** | **Describe the activities to be carried out by students in brief** | **Expected Frequency & Duration** | **Mode of Delivery (Online / Offline / Hybrid)** | **Tools / Platforms / Equipment / Machinery to be Used** | **Expected major Learning Outcomes** |
| 1 | Projects / Industry Assignments | Mini Project based on Unit 6: EV subsystem simulation or simple prototype (motor control, energy flow, or converter model) | 1 Project / 15 Hours | Hybrid / Offline | MATLAB/Simulink, DIY Kit | • Apply EV fundamentals to a working model • Understand subsystem behavior |
| 2 | Tutorials / Guided Technical Sessions | Unit-wise guided tasks: • Unit 1 – EV vs ICE comparison charts • Unit 2 – Block-diagram drawing of EV architecture • Unit 3 – Solving AC/DC & Converter numerical • Unit 4 – Motor/regen braking calculations | Weekly / 1–2 Hours | Online / Classroom | Worksheets, whiteboard | • Strengthen basic EV concepts • Improve analytical thinking |
| 3 | Master Classes / Expert Lectures by Industry Professionals | Industry talks related to Unit 1/4/5 (EV Ecosystem) | 1 or 2 Sessions / 2 Hours Each | Hybrid | Webinar tools, | • Understand industry trends • Learn real-world safety compliance |

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| 4 | Hackathons / Ideathons | Unit 2 & 4: "Design an efficient EV architecture for city commuting" or "Improve regen braking efficiency" | 1 Event / 6–8 Hours | Offline / Hybrid | Brainstorming templates, simulation tools | • Foster innovation • Integrate architecture + powertrain skills |
| 5 | Case Studies / Bootcamps / Workshops | • Unit 1: EV vs ICE cost & efficiency case study<br>• Unit 3: Workshop on rectifier/converter operation<br>• Unit 5: ISO 26262 / AIS-038 applied case | 2–3 Workshops / 3–4 Hours Each | Offline | Case sheets, trainer boards | • Real-world application<br>•Understanding compliance & testing |
| 6 | Quizzes / Competency-Based Evaluation | Unit-wise online quizzes covering all 6 units (weightage mapping) | Bi-weekly / 30–45 Minutes | Online | Google Forms / LMS | • Reinforce learning • Continuous performance evaluation |
| 7 | Hands-on Training / Lab Exercises / Tool-Based Learning | Based on Unit 3 & 4:<br>• AC/DC circuit building<br>• Rectifier & converter demo<br>• Basic motor drive testing<br>• Regenerative braking experiment (demo model) | Weekly / 2–3 Hours | Offline | Power supply kits, DSO, multimeter, motor kit | • Practical understanding of circuits<br>• Motor & power electronics familiarity |
| 8 | | | | Hybrid | Simulink | |

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|---|---|---|---|---|---|---|
| | Simulation-Based / Demonstration-Based Learning Sessions | • Unit 2: EV energy flow simulation<br>• Unit 3: Converter/rectifier simulation | 4–6 Sessions / 2 Hours Each | | | • Analyze EV behavior digitally • Gain system-level insight |
| 9 | Equipment Familiarization / Machine Handling | Unit 5: PPE usage, safety tools, HV awareness, lab protocols (ISO 26262 basics) | 2–3 Sessions / 2 Hours Each | Offline | PPE kit, LOTO, safety boards | • Safe handling of EV components • Awareness of regulatory requirements |
| 10 | Prototype Development / Capstone Build / Hardware Integration | Unit 6 mini-project prototype: basic EV system (motor + controller + DC supply or simulation equivalent) | 1 Prototype / 15–20 Hours | Offline | Small DC motor kit, controller, sensors (DIY) | • Hands-on model building • System integration skills |
| 11 | On-Site Industrial Visits / Shop-Floor Exposure / Live Demo | Visit aligned to Units 1,2, 3, 4: EV workshop / powertrain lab to observe components | 1 Visit / Full Day | Offline | Real workshop environment | • Visual understanding of EV layout<br>• Industry exposure |

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