GUJARAT TECHNOLOGICAL UNIVERSITY

BE 7 SEMESTER – OLD PAPER – SUMMER 2022 TO SUMMER 2026 – QUESTION BANK

Subject Name & Code: Electrical and Hybrid Vehicle - 3170923

Chapter 1: Introduction to Electric Vehicle

Repeated Questions:

1. EV Basics, Classification and History:

- **Q.** Prepare a block diagram of Battery Electric Vehicle (BEV) with all necessary components and explain it in brief. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; SUMMER 2025, 7 Marks)**
- **Q.** Give a detailed classification of Electrified Vehicles. **(SUMMER 2022, 3 Marks; WINTER 2022, 4 Marks; WINTER 2025, 4 Marks; SUMMER 2026, 7 Marks)**
- **Q.** Is Electric Vehicle (EV) a future of transportation? Justify your answer. **(SUMMER 2022, 4 Marks; WINTER 2025, 4 Marks)**
- **Q.** Give the Differences Between BEV, HEV and FCEV. **(WINTER 2022, 3 Marks; SUMMER 2025, 3 Marks)**
- **Q.** Explain the History of EVs and HEVs. **(SUMMER 2025, 7 Marks OR; WINTER 2025, 4 Marks; SUMMER 2026, 3 Marks)**

2. Vehicle Dynamics and Forces:

- **Q.** Derive the vehicle dynamic equation and explain all acting forces on vehicle with appropriate figure. [Diagram required – refer to the original question paper] **(SUMMER 2022, 4 Marks; WINTER 2025, 7 Marks; SUMMER 2026, 7 Marks)**
- **Q.** Explain different types of forces acting on vehicle going uphill. [Diagram required – refer to the original question paper] **(SUMMER 2023, 3 Marks OR; SUMMER 2024, 3 Marks OR; WINTER 2024, 7 Marks)**

Other Important Questions:

1. Importance, Merits and Challenges of EVs (Theory):

- **Q.** Explain the importance of Electric Vehicles. **(WINTER 2022, 3 Marks)**
- **Q.** What is the need and importance of electric and hybrid electric vehicles? **(WINTER 2024, 3 Marks)**
- **Q.** Discuss the challenges in development of electric vehicle and how to overcome it. **(WINTER 2023, 7 Marks)**
- **Q.** Write the advantages of adopting electrical vehicles in public & goods transport in India. **(WINTER 2023, 3 Marks)**
- **Q.** Write two merits and two demerits of electric vehicles. **(WINTER 2024, 4 Marks)**

2. Forces Acting on Vehicle (Theory):

- **Q.** Explain the different types of forces acting on vehicle in static & dynamic conditions with necessary calculations. [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks)**
- **Q.** Explain the role of rotating and stationary axis transformation in vehicle movement calculations. **(WINTER 2022, 3 Marks)**
- **Q.** Derive the expressions for various forces acting on the vehicle while moving on a flat surface. **(WINTER 2023, 7 Marks OR)**
- **Q.** Define rolling resistance for electric vehicle. **(WINTER 2023, 3 Marks)**

- **Q.** Discuss the aerodynamic force and aerodynamic drag in SUV car & Sedan car and conclude which one has perfect aerodynamic design. **(WINTER 2023, 4 Marks)**
- **Q.** Explain different types of forces acting on vehicle due to air friction. **(SUMMER 2025, 4 Marks)**

3. Solar Powered Electric Vehicle (Theory):

- **Q.** Explain Solar powered electric vehicle with its limitation. **(WINTER 2023, 4 Marks; WINTER 2025, 7 Marks OR)**
- **Q.** How does the integration of solar panels impact the range and performance of solar-powered vehicles? **(SUMMER 2026, 3 Marks OR)**

4. Numerical Problems:

- **Q.** Compute aerodynamic drag, rolling resistance & gradient force for the following vehicle assuming $\rho = 1.2$ kg/m^3 & $\theta = 8°$. Gross vehicle weight = 1500 kg, $C_D = 0.3$, Area = 2.5 m^2, $\mu = 0.015$, v = 80 kmph, Tyre radius = 0.3 m. Also compute total traction force assuming pick-up from 0 to 50 kmph in 20 sec, with linear acceleration & zero slope. **(WINTER 2024, 7 Marks OR)**

Chapter 2: Induction to Hybrid Electric Vehicle

Repeated Questions:

1. HEV Configurations and Block Diagrams:

- **Q.** Compare series hybrid and parallel hybrid system with their merits and demerits. [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks OR; SUMMER 2023, 7 Marks; SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks)**
- **Q.** What is a plug-in HEV? Explain with figure. [Diagram required – refer to the original question paper] **(SUMMER 2022, 4 Marks; WINTER 2024, 3 Marks; SUMMER 2025, 4 Marks OR)**
- **Q.** Draw and explain a series-parallel HEV with appropriate diagram. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; WINTER 2023, 7 Marks)**
- **Q.** Draw and explain Hybrid Electric Vehicle (HEV) with appropriate block diagram. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; WINTER 2025, 7 Marks)**

2. Comparison and Impact of HEVs:

- **Q.** Compare hybrid electric vehicles with conventional vehicles. **(SUMMER 2023, 3 Marks OR; SUMMER 2024, 3 Marks OR; WINTER 2024, 4 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 7 Marks)**
- **Q.** List the Economic and Environment impact of electric & hybrid vehicles. **(WINTER 2022, 4 Marks; SUMMER 2023, 3 Marks; SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks; WINTER 2025, 3 Marks)**

Other Important Questions:

1. HEV Concepts and Drive Train (Theory):

- **Q.** Explain the impact of modern drive-trains on energy supplies. **(SUMMER 2023, 7 Marks; SUMMER 2024, 7 Marks)**
- **Q.** Explain the operation of Drive Train mechanism in Hybrid Electric Vehicle. **(WINTER 2022, 7 Marks)**
- **Q.** Explain the concept of electrical components controlling in EV& Hybrid EV applications. **(WINTER 2022, 3 Marks OR)**
- **Q.** Define the term hybridness. **(WINTER 2022, 3 Marks OR; SUMMER 2025, 3 Marks OR)**
- **Q.** List the various components of HEV drive train. Mention the advantages of hybrid vehicles. **(WINTER 2024, 4 Marks OR)**
- **Q.** Explain the energy-saving potential of hybrid drive trains. **(WINTER 2025, 4 Marks)**
- **Q.** Explain the concept of a hybrid vehicle. How does it combine different power sources to improve fuel efficiency and reduce emissions? **(SUMMER 2026, 4 Marks)**
- **Q.** Classify the different types of Hybrid Electric Vehicle (HEV). What are the different types of hybrid power trains? **(SUMMER 2026, 7 Marks OR)**
- **Q.** How do hybrid systems affect the overall range of the vehicle? **(SUMMER 2026, 4 Marks OR)**

2. Architecture and Power Flow (Theory):

- **Q.** Draw the architecture of series hybrid and parallel hybrid EV. [Diagram required – refer to the original question paper] **(WINTER 2023, 4 Marks)**
- **Q.** Draw and explain architecture and power flow control of parallel hybrid electric drive train. [Diagram required – refer to the original question paper] **(WINTER 2024, 7 Marks)**
- **Q.** What is meant by (i) Series hybrid electric vehicle. (ii) Parallel hybrid electric vehicle. **(WINTER 2024, 4 Marks)**
- **Q.** Explain the series and parallel configuration of EHV. **(WINTER 2025, 3 Marks)**
- **Q.** Explain power flow in Parallel Hybrid HEVs. [Diagram required – refer to the original question paper] **(WINTER 2025, 7 Marks OR)**

3. Comparisons (Theory):

- **Q.** Give the comparison of IC engine vehicle, Hybrid EV and Battery EV. **(WINTER 2023, 4 Marks)**
- **Q.** Compare BEV, FCEV with IC engine vehicle for efficiency and performance. **(SUMMER 2022, 4 Marks OR)**
- **Q.** What are the key differences and similarities between electric drive train and the internal combustion engine (ICE) vehicle drive train? **(SUMMER 2026, 3 Marks)**
- **Q.** Compare hybrid vehicles with battery electric vehicles (BEVs). **(SUMMER 2026, 4 Marks)**

Chapter 3: Electric Drive Trains

Repeated Questions:

1. Electric Motor Drives for EV:

- **Q.** Explain the configuration and control of Induction Motor drives in EV. [Diagram required – refer to the original question paper] **(SUMMER 2023, 7 Marks OR; SUMMER 2024, 7 Marks OR; SUMMER 2026, 7 Marks OR)**
- **Q.** Why permanent magnet machines advantageous in Electrical Vehicles? **(SUMMER 2023, 4 Marks; SUMMER 2024, 4 Marks; WINTER 2025, 4 Marks OR)**
- **Q.** Explain the steady state modelling of permanent magnet machines. **(WINTER 2022, 4 Marks OR; SUMMER 2023, 4 Marks OR; SUMMER 2024, 4 Marks OR)**
- **Q.** Draw torque-speed characteristics of following motors and suggest best for EV with reason. (1) Induction Motor (IM) (2) Permanent Magnet Synchronous Motor (PMSM) (3) Switched Reluctance Motor (SRM) (4) Permanent Magnet Brushless DC Motor (PMBLDC). [Diagram required – refer to the original question paper] **(SUMMER 2022, 4 Marks OR; WINTER 2024, 4 Marks OR; SUMMER 2025, 4 Marks)**
- **Q.** Give the operation and controlling of DC motor drive. [Diagram required – refer to the original question paper] **(WINTER 2022, 4 Marks; SUMMER 2025, 4 Marks; SUMMER 2026, 4 Marks OR)**
- **Q.** Draw and explain driver circuit for 3 phase SRM. [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks OR; SUMMER 2025, 4 Marks)**

2. Braking, Drive Train Topologies and CAN Network:

- **Q.** Explain Electronically controlled regenerative braking system functioning as an ABS. [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks; SUMMER 2025, 7 Marks OR)**
- **Q.** Enlist the various types of electric drive train topologies used in the present. **(WINTER 2022, 3 Marks; WINTER 2023, 3 Marks; WINTER 2024, 7 Marks)**
- **Q.** Explain power flow control in electric drive-train topologies. **(SUMMER 2023, 7 Marks; SUMMER 2024, 7 Marks)**
- **Q.** Draw and Explain typical CAN network for HEVs. [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks OR; SUMMER 2025, 7 Marks)**

Other Important Questions:

1. Motor Selection and Classification (Theory):

- **Q.** How electric traction (locomotive) works? Explain with figure. [Diagram required – refer to the original question paper] **(SUMMER 2022, 3 Marks)**
- **Q.** Which types of qualities are required in electric motors for EV application? **(SUMMER 2022, 3 Marks OR)**
- **Q.** Classify the electric motors drives for EV and HEV application. **(WINTER 2024, 3 Marks)**
- **Q.** What is the advantage of AC motor over DC motors for EV applications? **(WINTER 2024, 3 Marks OR)**
- **Q.** Explain the classification of Electric Drives used in EVs. **(WINTER 2025, 4 Marks)**
- **Q.** Write the advantage of Switch Reluctance Motor. **(WINTER 2023, 3 Marks OR)**

2. Motor Drive Control (Theory):

- **Q.** Prepare and explain a complete driving control method for Induction Motor in electrical vehicle application. **(SUMMER 2022, 4 Marks)**
- **Q.** What is flux weakening in permanent magnet machines? **(SUMMER 2023, 3 Marks OR; SUMMER 2024, 3 Marks OR; SUMMER 2025, 3 Marks)**

- **Q.** Explain constant volts/Hz control strategy for closed loop induction motor drive. **(SUMMER 2023, 7 Marks OR; WINTER 2023, 4 Marks OR; SUMMER 2024, 7 Marks OR; WINTER 2025, 4 Marks OR)**
- **Q.** Explain Operation Configuration and controlling of SRM drives in EV. **(WINTER 2022, 4 Marks; WINTER 2024, 4 Marks; SUMMER 2026, 4 Marks)**
- **Q.** Draw and explain configuration of DC motor drive and its control strategy. [Diagram required – refer to the original question paper] **(WINTER 2023, 7 Marks OR)**
- **Q.** Explain the two-quadrant operation of chopper DC motor drive with suitable waveforms for electric vehicle. [Diagram required – refer to the original question paper] **(WINTER 2024, 7 Marks OR)**
- **Q.** Explain DC motor speed control techniques. **(WINTER 2025, 3 Marks)**
- **Q.** Draw and explain driver circuit for 3 phase BLDC motor. [Diagram required – refer to the original question paper] **(SUMMER 2025, 4 Marks OR)**

3. Braking and ABS (Theory):

- **Q.** Explain the need of Antilock brake system (ABS). **(SUMMER 2023, 3 Marks; SUMMER 2024, 3 Marks)**
- **Q.** Explain the braking of EV with & without Antilock Brake System (ABS). **(WINTER 2023, 3 Marks)**
- **Q.** Explain regenerative braking in EV and HEV. **(WINTER 2025, 3 Marks OR)**

4. Electric Drive Train Systems and Efficiency (Theory):

- **Q.** What is drive system efficiency? **(SUMMER 2023, 4 Marks; SUMMER 2024, 4 Marks)**
- **Q.** With the help of a neat block diagram explain different subsystems of electric drive train. [Diagram required – refer to the original question paper] **(WINTER 2024, 4 Marks)**
- **Q.** How does electric drive train function in electric vehicles, and what are its main advantages over traditional drive trains? **(SUMMER 2026, 4 Marks)**
- **Q.** Evaluate the feasibility of designing an electric vehicle without using gears. What are the potential benefits and challenges of such a design? **(SUMMER 2026, 7 Marks)**
- **Q.** Discuss various factors contribute to the efficiency of an electric drive train. **(SUMMER 2026, 3 Marks OR)**

Chapter 4: Types of Storage Systems

Repeated Questions:

1. Batteries:

- **Q.** Define the terms charge capacity, energy density, charge efficiency, specific energy, specific power, energy efficiency, C rate for batteries. / Define following terms (1) Specific energy... [Data truncated in source – refer to the original question paper] **(SUMMER 2022, 7 Marks; WINTER 2022, 7 Marks OR; SUMMER 2023, 7 Marks OR; SUMMER 2024, 7 Marks OR; WINTER 2024, 7 Marks; WINTER 2025, 7 Marks OR)**
- **Q.** Compare Lead-acid battery, nickel-cadmium battery and lithium-ion batteries for following terms (put specific values only) (1) Nominal voltage level (2) Specific energy (3) Energy density (4) Number of life cycle (5) Material of Anode, cathode and electrolyte (6) Recharge time. **(SUMMER 2022, 7 Marks OR; WINTER 2022, 7 Marks; SUMMER 2025, 7 Marks OR; WINTER 2025, 7 Marks)**
- **Q.** Explain about Lithium Based Batteries in Energy Storage System? **(SUMMER 2023, 4 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 4 Marks)**
- **Q.** What are the steps to find battery capacity for Electrical or Hybrid Electrical Vehicle? **(WINTER 2022, 4 Marks OR; SUMMER 2023, 4 Marks OR; SUMMER 2024, 4 Marks OR)**

2. Ultracapacitors and Flywheels:

- **Q.** Explain the difference between ultracapacitor and battery as an energy Storage device for EV. **(SUMMER 2022, 3 Marks OR; WINTER 2022, 7 Marks; SUMMER 2023, 4 Marks OR; WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks OR; SUMMER 2025, 7 Marks)**
- **Q.** Explain the Basic Principle of Super Capacitors based Energy Storage System in Hybrid Electric Vehicles. **(SUMMER 2023, 7 Marks; SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks; WINTER 2025, 4 Marks OR)**
- **Q.** Explain about Fly Wheel Technologies in Hybrid Electric Vehicles? **(SUMMER 2022, 3 Marks; SUMMER 2023, 4 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 4 Marks; WINTER 2024, 7 Marks OR; WINTER 2025, 3 Marks OR)**

3. Fuel Cells:

- **Q.** What are the main issues with fuel cells? **(SUMMER 2023, 3 Marks; SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks)**
- **Q.** Draw schematic diagram and explain Fuel cell based electrical vehicle and also discuss its limitations. [Diagram required – refer to the original question paper] **(WINTER 2023, 7 Marks; WINTER 2025, 3 Marks OR; SUMMER 2026, 7 Marks)**

Other Important Questions:

1. Batteries (Theory):

- **Q.** Enlist the limitation of Lead-Acid battery related to its application in EV. **(WINTER 2023, 3 Marks)**
- **Q.** Define C rate of battery for charging and discharging. **(WINTER 2023, 3 Marks OR)**
- **Q.** With neat diagram explain the construction and working of lead-acid battery. [Diagram required – refer to the original question paper] **(WINTER 2024, 7 Marks OR)**
- **Q.** Explain Metal Air Batteries in Details. **(WINTER 2025, 7 Marks)**
- **Q.** In Battery Electric Vehicle, what are the key factors influencing the performance and lifespan of batteries in EVs? **(SUMMER 2026, 4 Marks OR)**

2. Fuel Cells (Theory):

- **Q.** How fuel cell works? **(SUMMER 2022, 3 Marks OR)**
- **Q.** Write a Short Note on use of FC in EV applications. **(WINTER 2022, 3 Marks)**

- **Q.** Enlist various Fuel cell based energy generation technologies and discuss any one Fuel cell based energy generation in detail with schematic diagrams. [Diagram required – refer to the original question paper] **(WINTER 2023, 7 Marks OR)**

3. Energy Storage Systems (Theory):

- **Q.** Explain the Super Capacitor and Flywheel based energy storage system for EV and HEV applications. **(WINTER 2022, 7 Marks OR)**
- **Q.** Classified different Energy Storage devices used in Hybrid and Electric Vehicles. **(WINTER 2025, 3 Marks)**
- **Q.** Describe the energy storage requirements in hybrid and electric vehicles. **(SUMMER 2026, 3 Marks)**
- **Q.** Explain the concept of hybridization of different energy storage devices. **(SUMMER 2026, 3 Marks)**
- **Q.** Analyze the role of super capacitors in energy storage for electric vehicles. What are the advantages and limitations of using super capacitors in EVs? **(SUMMER 2026, 7 Marks OR)**

4. Numerical Problems:

- **Q.** How many batteries (12 V, 20 Ah) are required to fulfill the requirements of 108V, 60 Ah for EV. Provide connection diagram. [Diagram required – refer to the original question paper] **(SUMMER 2022, 3 Marks)**

Chapter 5: Modelling of Hybrid Electric Vehicle Range

Repeated Questions:

1. Driving Cycle:

- **Q.** What is Driving Cycle? [Diagram required – refer to the original question paper] **(SUMMER 2022, 7 Marks; SUMMER 2023, 4 Marks; SUMMER 2023, 7 Marks; SUMMER 2024, 4 Marks; SUMMER 2024, 7 Marks; WINTER 2025, 7 Marks OR; SUMMER 2026, 7 Marks)**

Other Important Questions:

None identified.

Chapter 6: Energy Management Strategies

Repeated Questions:

1. Energy Management Strategies:

- **Q.** Classify of different energy management strategies. **(SUMMER 2022, 4 Marks; SUMMER 2023, 3 Marks; SUMMER 2024, 3 Marks; WINTER 2024, 4 Marks OR; WINTER 2025, 3 Marks; SUMMER 2026, 4 Marks)**
- **Q.** List the optimization based strategies in Hybrid Electrical Vehicles. **(WINTER 2022, 4 Marks; WINTER 2024, 4 Marks; SUMMER 2025, 4 Marks OR)**

2. Charging Techniques:

- **Q.** State various charging techniques with schematics of charging stations. [Diagram required – refer to the original question paper] **(SUMMER 2022, 4 Marks OR; SUMMER 2023, 7 Marks OR; SUMMER 2024, 7 Marks OR; SUMMER 2025, 4 Marks; SUMMER 2026, 3 Marks; SUMMER 2026, 7 Marks OR)**

Other Important Questions:

1. Energy Management and V2X (Theory):

- **Q.** Explain following terms (1) Vehicle to Grid (V to G) (2) Vehicle to Load (V to L) (3) Vehicle to Vehicle (V to V). **(SUMMER 2022, 3 Marks; SUMMER 2025, 3 Marks OR)**
- **Q.** Explain the Energy Management concept for HEV. **(WINTER 2022, 3 Marks OR; SUMMER 2025, 3 Marks OR)**
- **Q.** List the Different methods of Energy Management used in EV applications. **(WINTER 2022, 4 Marks OR)**
- **Q.** Discuss in brief the implementation issues of energy management strategies in electric vehicles. **(SUMMER 2026, 3 Marks OR)**

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