Shri Vile Parle Kelavani Mandal's

# Dwarkadas J. Sanghvi College of Engineering

*(Autonomous College Affiliated to the University of Mumbai)*

## Scheme and detailed Syllabus (DJS22)

of

Honors Degree Program

in

# Electric Vehicle

*Revision: 2 (2024)*

*With effect from the Academic Year: 2024-2025*

## Scheme for Honors in Electric Vehicle
## (Academic Year 2022-2023)

| Sr. No. | Course Code | Course | Teaching Scheme (hrs.) | | | | Continuous Assessment (A) (Marks) | | | Semester End Assessment (B) (marks) | | | | | (A+B) | Total Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Th | P | T | Credits | Th | T/W | Total CA (A) | Th/ Cb | O | P | P&O | Total SEA (B) | | |
| **Semester V** | | | | | | | | | | | | | | | | |
| 1 | DJS22MEHN1C1 | Fundamental of Electric Vehicles | 4 | -- | -- | 4 | 35 | -- | 35 | 65 | -- | -- | -- | 65 | 100 | 4 |
| **Semester VI** | | | | | | | | | | | | | | | | |
| 2 | DJS22MEHN1C2 | Electric Drives and Control | 4 | -- | -- | 4 | 35 | -- | 35 | 65 | -- | -- | -- | 65 | 100 | 4 |
| 3 | DJS22MEHN1L1 | Electric Vehicle Laboratory I | -- | 2 | -- | 1 | -- | 25 | 25 | -- | 25 | -- | -- | 25 | 50 | 1 |
| **Semester VII** | | | | | | | | | | | | | | | | |
| 4 | DJS22MEHN1C3 | Energy Source Management | 4 | -- | -- | 4 | 35 | -- | 35 | 65 | -- | -- | -- | 65 | 100 | 4 |
| 5 | DJS22MEHN1L2 | Electric Vehicle Laboratory II | -- | 2 | -- | 1 | -- | 25 | 25 | -- | 25 | -- | -- | 25 | 50 | 1 |
| **Semester VIII** | | | | | | | | | | | | | | | | |
| 6 | DJS22MEHN1C4 | Electric Vehicle System Design | 4 | -- | -- | 4 | 35 | -- | 35 | 65 | -- | -- | -- | 65 | 100 | 4 |
| | | | 16 | 4 | -- | 18 | 140 | 50 | 190 | 260 | 50 | -- | -- | 310 | 500 | 18 |

| Honors in Electric Vehicles | T.Y B.Tech | Semester: V |
|---|---|---|
| Program: Mechanical Engineering | | |
| Course: Fundamentals of Electric Vehicles (DJS22MEHN1C1) | | |

**Pre-requisite:**

1. fundamentals of mechanical, electronics and electrical engineering.
2. Fundamentals of chemistry, physics and engineering mechanics.

**Objectives:**

1. To study different automotive components and subsystems used in electric vehicles.
2. To develop a comprehensive understanding of vehicle dynamics and stability principles.
3. To provide a broad understanding of transmission systems used in electric vehicles.
4. To understand the principles of electrochemical reactions in batteries and analyze the parameters governing battery performance and efficiency.
5. To equip students with the knowledge and skills necessary for the selection and sizing of electric motors for diverse applications, covering criteria assessment, performance analysis, and matching to load requirements.

**Outcomes:** On completion of the course, the learner will be able to:

1. To explain the fundamentals of electric vehicles and its major parts.
2. Classify the chassis used in electric vehicle and select a suitable body type for given requirements.
3. Apply vehicle dynamics and stability principles to analyze and optimize vehicle performance, including maximum speed, gradeability, and acceleration.
4. Differentiate between different types of transmission systems, including manual, automatic, AMT, and CVT, and select suitable transmission system for a vehicle to be designed.
5. Evaluate different types of batteries based on their electrochemical properties and determine their suitability for specific applications.
6. Evaluate vehicle requirements, motor criteria, and interpret performance characteristics to effectively select and size electric motors for various applications.

| Fundamentals of Electric Vehicles (DJS22MEHN1C1) | | |
|---|---|---|
| **Unit** | **Description** | **Duration** |
| **1** | **Introduction to Electric Vehicles (EV)**<br>• Brief history of EV.<br>• Electric vehicle market.<br>• Need of EV.<br>• Types of EVs and their components: Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs), Hybrid Electric Vehicles (HEVs)<br>• EV specifications.<br>• General layouts of the EVs; Introduction to the various sub-systems used in EVs.<br>• EV classification: Battery Electric Vehicles (BEVs), Fuel-Cell Electric Vehicles (FCEVs).<br>• Comparison of EV with other types of vehicles.<br>• Advantages and Disadvantages of EV.<br>• Overview of EV manufacturers.<br>• National Policy for adoption of EVs. | 10 |
| **2** | **Vehicle Mechanics**<br>• Introduction to chassis. | 4 |

| | | |
|---|---|---|
| | • Classification of chassis.<br>• Frame.<br>• EV classification based on body types.<br>• Body and Chassis Materials.<br>• Vehicle dimensions.<br>• Government regulations. | |
| **3** | **Vehicle Dynamics and Stability**<br>• Types of wheel rims, wheel dimension.<br>• Tyre: properties, specifications, types, construction, tread patterns.<br>• Study principles of rolling, pitch and yaw velocity and moments.<br>• Drag, lifts, resistance, body loads and load calculation.<br>• Vehicle resistance: rolling resistance, grading resistance, aerodynamic drag.<br>• Dynamic equation, Vehicle performance (Maximum speed, gradeability and acceleration).<br>• Calculation of acceleration force, maximum speed.<br>• Tractive effort, Torque required on the wheel.<br>• Torque speed characteristics of electric vehicle.<br>• Aesthetics and ergonomics consideration for stability and control. | 10 |
| **4** | **Transmission Systems**<br>• Transmission gears, Manual Transmission (MT), Automatic Transmission (AT), Automated Manual Transmissions (AMT), Continuously Variable Transmissions (CVT).<br>• Manual transmissions powertrain layout and Manual Transmission Structure, Power Flows and Gear Ratios, Manual Transmission Clutch and its structure. Drivetrain and Differential. | 8 |
| **5** | **Power Unit: Batteries Technologies**<br>• Types of batteries: Lead acid battery, Nickel based batteries, Sodium based batteries, Lithium based batteries - Li-ion and Li-poly, Metal air battery, Zinc chloride battery, Graphene Battery.<br>• Introduction to Electrochemical Battery.<br>• Electrochemical Reactions.<br>• Battery Parameters: Battery capacity, discharge rate, charging rate, SOC, SOD, SOH, DOD, thermodynamic voltage, specific energy, specific power, energy efficiency.<br>• Energy Storage Systems: Ultra capacitors; Flywheel Energy Storage System; Hydraulic Energy Storage System; Comparison of different Energy Storage System. | 10 |
| **6** | **Selection/ Sizing of Electric Motor**<br>• Overview of electric drives and their applications.<br>• Comparison of various types of electric drives.<br>• Motion profile: acceleration, steady operation and deceleration profiles;<br>• Criteria for selecting electric motors: torque, speed, power rating, efficiency, etc.<br>• Understanding motor performance characteristics: torque-speed curve, efficiency map, etc.<br>• Considerations for motor sizing and matching to load requirements.<br>• Suitability of electric motor in different domain for 2-, 3-, 4-wheeler and large size vehicles.<br>• Real life examples/case studies; | |
| | **Total** | **52** |

**Books Recommended:**

*Textbooks:*

- Vehicle Powertrain Systems by Behrooz Mashadi and David Crolla, Wiley, 2012
- Automotive Aerodynamics by Joseph Katz, Wiley, 2016
- Automotive Chassis Engineering, by David C. Barton and John D. Fieldhouse, Springer, 2018
- Automotive Engineering Powertrain, Chassis System and Vehicle Body Edited by David A. Crolla, Elsevier,2009
- Automotive Power Transmission Systems by Yi Zhang and Chris Mi, Wiley, 2018
- Linear Electric Machines, Drives, and MAGLEVs Handbook, by Ion Boldea, CRC Press. 2013
- Modern Electric, Hybrid Electric, and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, and Ali Emadi, CRC Press 2005
- Electric Vehicle Technology Explained by James Larminie and John Lowry, John Wiley, 2003
- Electric and Hybrid Vehicles- Design Fundamentals by Iqbal Husain, CRC Press, 2005

*Reference Books:*

- Engineering Design Synthesis: Understanding, Approaches and Tools, A. Chakrabarti, Springer, 2002.
- Encyclopaedia of Automotive Engineering edited by David Crolla et al, Wiley, 2014
- Design and Control of Automotive Propulsion Systems by Zongxuan Sun and Guoming Zhu, CRC Press, 2015
- The Automotive Transmission Book by Robert Fischer, Ferit Küçükay, Gunter Jürgens, Rolf Najork, and
- Burkhard Pollak, Springer, 2015
- Noise and Vibration Control in Automotive Bodies by Jian Pang, Wiley, 2019

*Web References:*

- Electric Vehicles Part 1 (https://nptel.ac.in/courses/108102121)
- Introduction to Hybrid and Electric Vehicles (https://nptel.ac.in/courses/108103009)
- Fundamentals of Electric vehicles: Technology & Economics (https://nptel.ac.in/courses/108106170)
- Electric vehicles and Renewable energy (https://nptel.ac.in/courses/108106182)

Prepared by Checked by Head of the Department Principal