



भारतीय प्रौद्योगिकी संस्थान दिल्ली  
Indian Institute of Technology Delhi

# Certificate Programme in Hybrid Electric Vehicles (HEVs) Design

Technical Orientation: September 29, 2024  
6 Months | Live-Online Sessions | Campus Visit



Programme offered by Continuing Education Programme (CEP), IIT Delhi

# Green on the Move: The Rise of Electric Vehicles in India

In 2023, India had more than 2.3 million electric vehicles.\* By 2035, the Indian automobile industry is set to become fully electric.\* As government bodies and environmental organisations try to find sustainable lifestyle choices, vehicle owners are doing their bit by shifting to EVs and hybrid electric vehicles (HEVs). These vehicles will ensure reduced carbon footprints and help nature in replenishing depleting fuel resources. With the ongoing research in EV technology, the fast adoption of charging infrastructure and the rise of EVs on Indian roads, India is on its way to joining the list of major countries with energy-efficient mobility solutions.



**1.53 Million**

**In 2023, 1.53 million EVs were sold in India'**

(CareEdge Report, 2024)

**66%**

**EV sales in India are expected to rise to 66% in 2024**

(Counterpoint Report, 2024)

**210%**

**Electric two-wheelers recorded a sales increase of 210%, the largest increase, in FY2023 over FY2022**

(JMK Research & Analytics: Annual India EV Report Card, FY2023)

**150%**

**E-car sales recorded an increase of 150% in FY23 over FY22**

(JMK Research & Analytics: Annual India EV Report Card, FY2023)

# Programme Overview

The IIT Delhi programme in Hybrid Electric Vehicles (HEVs) Design is a one-of-a-kind programme in India that integrates key concepts spanning thermodynamics, IC engines, electric machines and drives, power electronics, automotive hybridisation, and battery design and modelling. Designed to bridge the gap between conventional automotive engineering and the burgeoning EV and Hybrid EV space, this programme provides the skills and insights needed to navigate the complexities of modern vehicle electrification.

Delivered by the faculty of the Centre for Automotive Research and Tribology (CART) at IIT Delhi, this programme aligns closely with the objectives outlined by the Government of India's Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) scheme. Participants can expect a dynamic learning experience, featuring weekly live online sessions led by IIT Delhi faculty. The programme's pedagogical approach emphasises a blend of theoretical learning, real-world industry insights, hands-on assignments, an individual capstone project, and an immersive visit to the state-of-the-art laboratories and facilities at the IIT Delhi campus.



**Starts On**  
29 September 2024

**Duration**  
6 months

**Programme Fee**  
INR 1,10,000 + GST

**Format**  
Live Online

# Programme Highlights



Undertake weekly **live sessions** with IIT Delhi faculty who have designed the programme in line with the FAME scheme



Experience **campus immersion** at the state-of-the-art facilities at the CART, IIT Delhi



Gain **industry insights** from Programme coordinators who have successfully delivered this course for two years in the UK to various automotive organisations such as Ford and Dyson.



Gain practical understanding of the curriculum by working on a **capstone project**, closely guided by IIT Delhi faculty



Delve into peer-to-peer learning, and expand your **professional network** in the automotive industry.



Receive **certification** from IIT Delhi, ranked NIRF#2, Engineering 2023.

# Who Is This Programme For?

- Engineers (Mechanical, Electrical, Automotive, and allied areas) seeking to establish a strong foundation in EV/HEV technology
- Professionals transitioning from traditional internal combustion engine technology to EVs and HEVs
- Professionals aiming to fortify existing expertise in the EV/HEV sector

# Programme Modules At A Glance

- Design, Operations and Performance of Internal Combustion Engines (ICE)
- Design Requirement and Operating Characteristics of Hybrid Electric Vehicle (HEV)
- Complexity of Technology Integration
- Energy Storage Systems and Design, Operation and Modelling of Batteries
- Battery Pack Selection
- Powertrain Architectures Categories and Selection
- Automotive Hybridisation and Electrification (AHE)
- Power Electronics and Power Drives
- Perform Engine Sizing
- Characterise Battery for Model Development and System Integration



# Programme Modules

## Module 1: Elementary Thermodynamics

- ⊗ Types of Systems
- ⊗ Laws of Thermodynamics
- ⊗ Thermodynamical Quantities: Heat, Work, Internal Energy, Entropy, etc
- ⊗ Reversible and Irreversible Processes
- ⊗ Cycles Used for Power Generation

## Module 2: Internal Combustion Engines (ICE)

- ⊗ Elementary Thermodynamics
- ⊗ Types of ICE and Different Components of an Engine
- ⊗ Air-standard Cycles
- ⊗ Fuel-air and Actual Cycles
- ⊗ Combustion in Engines

## Module 3: AHE (Automotive Hybridisation and Electrification)

- ⊗ Types of Hybrids
- ⊗ Hybrid Categories
- ⊗ Hybrid Architectures
- ⊗ Benefit Mechanisms of a Hybrid Vehicle
- ⊗ Design of Hybrid and Realisation: Case Studies

## Module 4: Electric Machines

- ⊗ Introduction: Fundamentals of Electric Motors
- ⊗ Electro-Magnetic Force (EMF)
- ⊗ Synchronous Machines
- ⊗ Brush-Less DC motor (BLDC) and Permanent-Magnet Synchronous Motor (PMSM)
- ⊗ Asynchronous Machines: Induction Motor

# Programme Modules

## Module 5: Propulsion Technology

- Power Electronic Devices: BJT, MOSFET, IGBT
- Machine Control Basics
- Sector Control and FOC (Field Oriented Control)
- Inverters
- Vector Control Applications

## Module 6: Energy Storage Systems

- Introduction
- Energy Storage technologies: Mechanical, Electrostatic, Electrochemical
- Battery Systems and Design Principles
- Introduction to Fuel Cell Vehicles
- Supercapacitors

## Module 7: Battery Modelling and Testing

- Types of Models: Equivalent Circuit Models and Electrochemical Models
- State Estimation Techniques
- Battery Reliability and Health Management
- Battery Safety, Testing and Thermal Runaway
- BMS Development

## Seminar 1: Hybrid Architecture

## Seminar 2: Engine Dynamics

*Note:*  
-Modules/ topics are indicative only, and the suggested time and sequence may be dropped/ modified/ adapted to fit the total programme hours.  
-Case studies, real world examples and numerical illustrations are an integral part of multiple modules included in the course.  
-The primary mode of learning for this programme is via live online sessions with faculty members.  
-Post session video recordings will be made available for additional two months after the last session of the programme.  
-Emeritus or the institute does not guarantee availability of any session recordings.

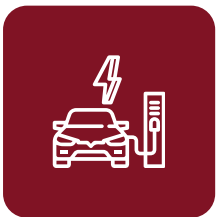
# Tools



Learners will engage in hands-on problem-solving **demonstrations** utilising industry-standard tools such as **MATLAB, Simulink and Python**. They will gain exposure to Embedded Systems and IoT Tools during the course. Through practical application exercises, participants will gain proficiency in leveraging these software platforms to analyse, model, and simulate complex engineering systems encountered in electric and hybrid electric vehicle technology.

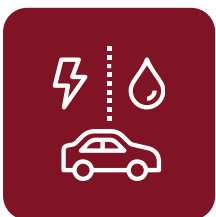
*Note:*  
-All product and company names mentioned in this material are trademarks or registered trademarks of their respective holders. Their use does not imply any affiliation with or endorsement by them.  
-The tools shall not be taught from scratch.

## Introduction to Software and Simulations



### GT Suite:

GT Suite offers comprehensive capabilities for complete vehicle development, including advanced battery models. You will get an overview of GT Suite to simulate and optimise various aspects of vehicle performance, with a focus on understanding and enhancing battery efficiency and functionality in EVs and HEVs.



### A CarSim Demonstration of EV and HEV Capabilities:

This software tool is helpful in vehicle system simulation and determining the battery performance under a variety of drive cycle conditions. You will get an overview of this software which is essential for people working on EV batteries.





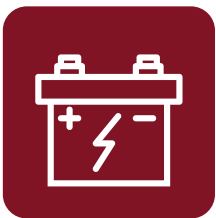
# Campus Immersion

Towards the end of the programme, students will visit the **Centre for Automotive Research and Tribology (CART) at the IIT Delhi campus** for hands-on experience with cutting-edge facilities and equipment. This visit is a cornerstone of the programme, empowering students to develop practical skills essential for success in electric and hybrid vehicle technology.



## HEV Training Bench:

Students will explore different hybrid vehicle configurations first-hand. Equipped with various motor types, loads, and engines, this bench offers a practical environment for conducting experiments and gaining insights into hybrid vehicle systems. Through hands-on, students will deepen their understanding of hybrid vehicle technologies and their applications in real-world scenarios.

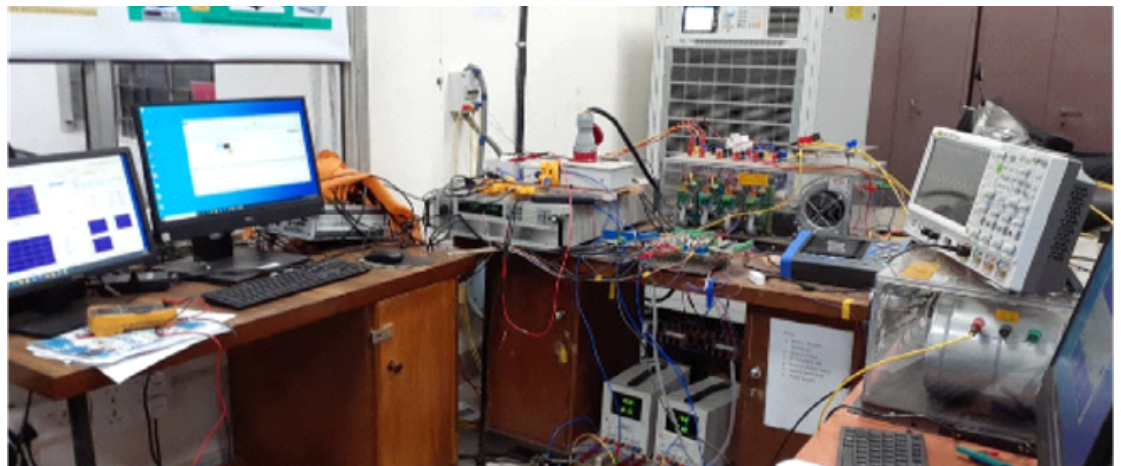
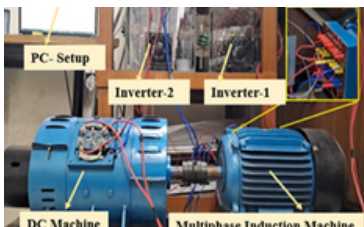


## Battery Technology Lab:

The lab is equipped with cutting-edge state-of-the-art battery testing equipment. From battery pack regenerative testers to thermal chambers, this lab offers a comprehensive suite of tools for cell electrical characterisation, aging testing, and beyond. Participants will have the opportunity to operate and understand the functionality of these advanced instruments, gaining practical insights into battery technology and its applications in EVs and HEVs.

**Note:**

- The campus immersion is optional for the participants.
- One-day campus immersion will not provide accommodation to the participants.



# Programme Coordinator



## Dr Husain Kanchwala

Assistant Professor  
CART, IIT Delhi

Dr Husain Kanchwala is an Assistant Professor at the Centre of Automotive Research and Tribology, IIT Delhi. Prior to this, he was an Assistant Professor at the University of Warwick, United Kingdom (2019–2021). At Warwick, he developed multiple courses on automotive hybridisation and electrification and worked on motorcycle stability. He was a Senior Research Fellow at the Defence Academy of the United Kingdom (2018-2019). He was the project leader of the Multi-Car Collision Avoidance (MuCCA) project, which helped to build a framework to enhance road safety for autonomous vehicles running in an urban environment. His post-doctoral work at Cranfield University (2017-2018) involved developing an off-road engineering simulator (ORES). This was a hardware-in-the-loop transient dynamometer for testing Jaguar Land Rover vehicles. He obtained his PhD from Indian Institute of Technology, Kanpur in Mechanical Engineering in 2017. In doctoral research, he proposed new theoretical formulations for a generalised quarter-car suspension model, modelling of suspension components using fractional derivatives, and Laplace domain model development of a vehicle using low-cost instrumentation systems. His research interests lie in the area of vehicle dynamics and control, vibration of continuous systems, rotor dynamics, battery modelling and hysteresis.

*Note: Programme faculty might change due to unavoidable circumstances, and revised details will be provided closer to the programme start date.*



# Programme Coordinator



## Dr Saurabh Saxena

Assistant Professor  
CART, IIT Delhi

Dr Saurabh Saxena received his PhD degree (2020) in mechanical engineering from the University of Maryland, College Park, USA, and BTech degree (2011) in electrical engineering from the IIT (BHU) Varanasi, India. He currently works as an Assistant Professor at IIT Delhi's Centre for Automotive Research and Tribology (CART). Previously, he worked as a Battery algorithm engineer at Apple Inc (United States ) and as a postdoctoral researcher in the applied materials division at Argonne National Laboratory (United States). Prior to his PhD, he worked on the modelling of lithium-ion batteries and supercapacitors at the IISc Bangalore, India. He has been involved in various battery research projects for the past 10 years and has published more than 20 research articles. His research interests include lithium-ion batteries, battery management system, machine learning for prognostics and health management, and accelerated degradation testing.

*Note: Programme faculty might change due to unavoidable circumstances, and revised details will be provided closer to the programme start date.*



# Programme Certificate

Candidates who score at least 50% marks overall and have a minimum attendance of 80%, will receive a Certificate of Successful Completion from CEP, IIT Delhi. Candidates who score less than 50% marks overall and have a minimum attendance of 70%, will receive a Certificate of Participation from CEP, IIT Delhi. The organising department for this programme is the Centre for Automotive Research and Tribology (CART), IIT Delhi.



Programme Code: .....

  **Indian Institute of Technology Delhi**   
HAUZ KHAS, NEW DELHI- 110016

**Department/Centre/School of .....**

**Continuing Education Programme**  
**On**  
**Title of the Programme**

This is to certify that  
Mr./Ms. **Name Of The Participant**

has successfully completed the online certificate programme on "Title of the Programme" held from ..... to ..... by the Indian Institute of Technology Delhi.

Prof. Programme Coordinator      Prof. Head of the Department      Prof. Head/Associate Head, QIP/CEP

An initiative under eVIDYA@IITD (ई-विद्या@IITD) 



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Prof. Programme Coordinator      Prof. Head of the Department      Prof. Head/Associate Head, QIP/CEP

An initiative under eVIDYA@IITD (ई-विद्या@IITD) 

**Note: :**

-All certificate images are for illustrative purposes only and may be subject to change at the discretion of IIT Delhi.

-Only e-certificate will be issued by CEP IIT Delhi.

-The organising department for this programme is Center for Automotive Research and Tribology (CART).

# Learning Outcomes

After completing this programme, you will be able to:



Explain internal combustion engine (ICE) operating characteristics



Explain process of vehicle hybridization and electrification



Explain various electric machines and propulsion technologies used in HEVs



Explain the working principles of different types of energy storage systems



Explain testing and modeling methods to characterize battery performance, reliability, and safety

# Programme Details

## Programme Schedule

<b>Duration</b>	6 Months
<b>Technical Orientation</b>	Sep 22, 2024
<b>Academic Orientation</b>	Oct 13, 2024
<b>Live Online Sessions</b>	Oct 20, 2024, Sunday 3:30 PM to 6:30 PM

## Eligibility\*

- Engineering graduates (Mechanical, Electrical, Automotive, and allied areas) or Diploma Holders (10+2+3) with more than 40% marks are eligible.
- Engineering Students (10+2+4) in their 6th, 7th, or 8th semesters are also eligible to apply. Please submit the University grade/marks sheet for the latest semester.

## Selection Process:

Screening and selection will be done by IIT Delhi

## Evaluation

The evaluation will be at the faculty's discretion. The assessment may include End-Term and Project Evaluation.

# Payment Schedule

**Programme Fee**                      INR 1,10,000 + GST

	Instalment 1	Instalment 2	Instalment 3
<b>Remarks</b>	Within 5 days post-selection	Sep 26, 2024	Dec 26, 2024
<b>Amount</b>	INR 22,000 + GST	INR 44,000 + GST	INR 44,000 + GST

### Note:

- The actual programme schedule will be announced closer to the programme start.
- GST (currently @ 18%) will be charged extra on these components.
- Postage charges for books and study materials sent to locations outside of India will be paid for by the student.
- Loan and EMI services are provided by Eruditus Learning Solutions Pte Ltd, and IIT Delhi is not responsible for the same.

<b>Last Date to Apply</b>	July 09, 2024
<b>Shortlisted Candidates Will Be Informed by</b>	July 16, 2024
<b>Last Date to Submit the Fee</b>	Within 5 Days Post-selection

Note: Applications will be reviewed based on eligibility and subsequent shortlisting process as laid down by the Programme Coordinators.

**All fee should be submitted in the IIT Delhi CEP account only, and the receipt will be issued by IIT Delhi CEP account for your records.**

\* 6 month duration is counted from first academic session i.e. (October 20, 2024) and the same date will also be mentioned on the certificate as the starting date of the programme. The mentioned minimum eligibility criteria is not a guaranteed for selection. Selection cut-off for this programme can be altered on the discretion of IIT Delhi.

# Application Requirements

## Graduation and Post-Graduation Education:

- Consolidated Graduation Marksheet (All Semester)
- Final year students may submit the marksheets up to the previous semester

## ID Proof:

- Any Government-issued photo ID like PAN Card/ Driving License/ Passport, etc.
- Submission of passport-size photo during application is mandatory

# System Requirements

This programme includes online learning classes conducted on Zoom. To attend an online learning class you will need to have a PC/ Laptop/ Mac with:

- Speakers and microphone: built-in or a USB plug-in or wireless Bluetooth
- Webcam: built-in or USB plug-in
- Processor: with Dual Core 2Ghz or higher (i3/ i5/ i7 or AMD equivalent)
- RAM: 4 GB or higher
- OS: Either MacOS 10.7 or higher OR Windows 8 or higher
- An internet connection: Minimum bandwidth of 3.0 Mbps (up/ down)
- Browser: IE 11+, Edge 12+, Firefox 27+, Chrome 30+
- Zoom software client installed on your PC/ Laptop/ Mac

We use the Zoom software application to conduct online learning classes. Zoom works on a variety of PCs/ Laptops/ Mac systems and also on phones and tablets.

You can join your online learning class from a phone or tablet if it supports the Zoom client.

We recommend that you attend classes from a PCs/ Laptops/ Mac.

## WITHDRAWAL AND REFUND FROM PROGRAMME

- Candidates can withdraw within 15 days from the Programme Start Date. A total of 80% of the total fee received will be refunded. However, the applicable tax amount paid will not be refunded on the amount paid.
- If you wish to withdraw from the programme, you must email [cepaccounts@admin.iitd.in](mailto:cepaccounts@admin.iitd.in) and [iitd.execed@emeritus.org](mailto:iitd.execed@emeritus.org), stating your intent to withdraw. The refund, if applicable, will be processed within 30 working days from the date of receiving the withdrawal request.

# About IIT Delhi

The Indian Institute of Technology Delhi (IIT Delhi) is one of the five initial IITs established for training, research and development in science, engineering and technology in India. Established as College of Engineering in 1961, the Institute was later declared as an Institution of National Importance under the "Institutes of Technology (Amendment) Act, 1963" and was renamed as "Indian Institute of Technology Delhi". It was then accorded the status of a Deemed University with powers to decide its own academic policy, to conduct its own examinations, and to award its own degrees. Since its inception, over 48000 have graduated from IIT Delhi in various disciplines including Engineering, Physical Sciences, Management and Humanities & Social Sciences. Of these, nearly 5070 received PhD degrees. The rest obtained a Master's Degree in Engineering, Sciences and Business Administration. These alumni today work as scientists, technologists, business managers and entrepreneurs. There are several alumni who have moved away from their original disciplines and have taken to administrative services, active politics or are with NGOs. In doing so, they have contributed significantly to the building of this nation, and to industrialisation around the world.

For more details, please visit: [www.iitd.ac.in](http://www.iitd.ac.in)

## About Continuing Education Programme (CEP)

Executive Education is a vital need for the organisations to build a culture that promotes newer technologies and solutions and builds a workforce that stays abreast of the rapidly transforming needs to the technological, business and regulatory landscape. Committed to the cause of making quality education accessible to all, IIT Delhi has launched Online Certificate Programmes under eVIDYA@IITD (ई-विद्या@IITD): enabling Virtual & Interactive-learning for Driving Youth Advancement@IITD for Indian as well as international participants. These outreach programmes offered by the Indian Institute of Technology Delhi (IIT Delhi) are designed to cater to the training and development needs of various organisations, industries, society and individual participants at national and international level with a vision to empower thousands of young learners by imparting high-quality Online Certificate Programmes in cutting-edge areas for their career advancement in different domains of engineering, technology, science, humanities and management. For more details, please visit: <http://cepqip.iitd.ac.in>



**APPLY NOW**

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For registration and any other information,  
please get in touch with us at [iitd.execed@emeritus.org](mailto:iitd.execed@emeritus.org)

For any feedback, please write to CEP IIT Delhi  
at [contactcep@admin.iitd.ac.in](mailto:contactcep@admin.iitd.ac.in)

 [WhatsApp the Advisor On +91 86570 38243\\*](https://wa.me/918657038243)

\*This number does not accept any calls. Please message your queries.



Online Certificate Programmes are offered by the Indian Institute of Technology Delhi under the aegis of Continuing Education Programme (CEP) so that the Institute can realise its vision of serving as a valuable resource for industry and society, and fulfil its mission to develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge in a range of professions.

**Programme offered by Continuing Education Programme (CEP), IIT Delhi**