CODE IIT Madras offers

Certificate Programme on eMobility

CPoeM

COURSE BROCHURE

https://code.iitm.ac.in/

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ABOUT THE COURSE

Centre for Outreach and Digital Education (CODE), IIT Madras, offers a short-term executive certificate programme on eMobility (CPoeM). CPoeM has been curated by IIT Madras – along with experts from industry – to provide a comprehensive overview of eMobility and Electric Vehicles (EVs). While foundational theory is provided in technical areas such as Batteries, Power Electronics, EMI/EMC market, cost and industry – specific areas like Vehicle Engineering and Development are also covered. The course is designed for working professionals who are looking to acquire basic exposure and awareness in eMobility. After completion, the candidates can choose to dive deeper into those specific areas that are of interest to them: in further programs IIT Madras plans to launch.

WHY THIS COURSE?

With a rapid switch in the focus of the automobile industry, from ICE Vehicles to Electric Vehicles, there is a huge requirement for skilled human resources who have a sound knowledge of Electric Vehicles, and their constituents and ecosystems. The current requirement of the industry and among academicians can only be fulfilled by providing a source of learning in the EV domain. This course is specifically designed to make candidates aware about the Electric Vehicle and its technology, and to act as a bridge between Industry and Academia.

COURSE MODULES

01 eMobility Ecosystem

02 Economics for eMobility

03 Vehicle Engineering and Development

04 Vehicle Dynamics and Control

05 Battery Technology

06 Power Electronics

07 Motors for Electric Vehicles

08 Thermal Management for Electric Vehicles

09 System Integration and Calibration

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11 Charging Infrastructure

12 Materials for eMobility

13 Electromagnetic Compatibility for Electric Vehicles

INTENDED AUDIENCE

Automotive Engineers (in Original Equipment Manufacturers, Component Suppliers, Service Providers, Aftermarket Dealerships), and for those intending to upskill themselves in the eMobility domain.

ELIGIBILITY CRITERIA

Bachelor's degree in an allied Engineering or Science domain (BTech/BE/BSc, etc.).

COURSE POLICY

Please refer **HERE** to read about policies on Admission, Pricing, Payment and Attendance.

COURSE FEES

Indian participants : **Rs. 1,00,000 + 18%GST**

International participants : **USD 1430**

Number of Participants	**100 members**
Mode of Course	**Recorded lectures and live sessions**

CLICK HERE TO REGISTER

ABOUT CODE

Established in 1986, the Centre for Continuing Education (CCE), now renamed Centre for Outreach and Digital Education (CODE), coordinates the outreach and online programmes of IIT Madras. The centre's activities include coordinating the Web-enabled MTech programs; coordinating NPTEL and GIAN courses; coordinating IIT Madras' BS in Data Science; Short-Term skilling programmes targeted towards industry; Quality Improvement programmes, meant for faculty in engineering institutions; support for conferences, book writing, etc. For more details, **please refer https://code.iitm.ac.in/**

1 eMobility Ecosystem

Faculty Profile:

Mr. Thiru Srinivasan
CEO, Center of Excellence in Advanced Automotive Research (CAAR),
IIT Madras

Module Duration: 4 hours

Describe the module you are planning to deliver: The module on eMobility Ecosystem will give students an idea about the overall EV Ecosystem and the various techno-commercial trends that are unfolding both globally and, more specifically, in India.

Topics covered:
- Market trends, user criteria, technology trends in various aggregates in an EV
- Cost trends as well as supply chain trends
- Attention to regulatory policies and environmental issues and trends

Learning outcomes of this module:
- Ability to understand and address user needs, including performance, costs and safety
- Ability to understand and apply new solutions in eMobility on account of evolving technologies
- Ensure compliance to regulatory needs, standards and recyclability requirements while engineering or developing an EV or its aggregate

Applications of this module:
- Product planning, program management for vehicles in OEMs
- Development and testing of aggregates for an EV
- Context and direction setting in non-engineering functions like sourcing, quality, production and recycling

2 Economics for eMobility

Faculty Profile:

Prof. Santosh Kumar Sahu
Associate Professor,
Dept. of Humanities and Social Sciences,
IIT Madras

Module Duration: 6 hours

Describe the module you are planning to deliver: The module on Economics of eMobility will give students an idea about the basic principles of economics, that are applied in explaining the EV Ecosystem both globally and, more specifically, in India.

Topics Covered:

- Basic economics principles, Economics of EV, Industrial Policy and Energy Economics, Economics of Externalities and renewable energy, The Market for EVs and Supply Chain Challanges

Learning outcomes of this module:

- Ability to understand basic concepts of economics
- Ability to understand the economics of externalities
- Application of economic theories in the context of EVs

Applications of this module:

- Business trends and economics of EV
- Demand and supply scenarios of EV
- EV and the economics of global climate change

3 Vehicle Engineering and Development

Faculty Profile:

Mr. B. Balaji

Guest Faculty,

Dept. of Engineering Design,

IIT Madras

Module Duration: 12.5 hours

Describe the module you are planning to deliver: This module will give the students an idea about the overall Electric Vehicle Engineering and Development in terms of understanding customer attributes, functional requirements.

Topics Covered:

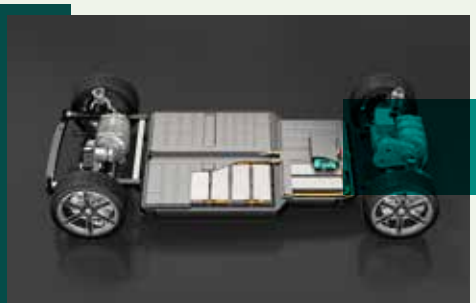
- A discussion on how to convert the parameters customer attributes and functional requirementsinto engineering specifications leading towards specification and selection of aggregates andsystems to meet various targets including vehicle performance, operational economy, durability, regulatory requirements

Learning outcomes of this module:

- Possess understanding of customer focused electric vehicle development
- Understand vehicle architecture, Modularity and Vehicle packaging
- Understand intended vehicle application, operation duty cycle etc
- Have an exposure to key regulatory requirements, safety and environmental aspects
- Understand the electric vehicle contemporary development process practiced in automotive organizations with a step by step approach

Applications of this module:

- This module would be useful for people who are engaged by Vehicle OEMs – product development engineering division of the Electric Vehicle (EV) involving design and development process systems and aggregate suppliers, and EV start-ups, engineering services organizations focussing on electric vehicles.



4 Vehicle Dynamics and Control

Faculty Profile:
Prof. C. S. Shankar Ram
Professor,
Dept. of Engineering Design,
IIT Madras

Module Duration: 11 hours

Describe the module you are planning to deliver: This module on Vehicle Dynamics and Control discusses the key concepts related to the analysis of road vehicle dynamics and control systems.

Topics Covered:
- Introduction to dynamic systems
- Understanding the three broad sub-domains of vehicle dynamics: longitudinal dynamics, lateral dynamics, and vertical dynamics
- Overview of key concepts from control systems

Learning outcomes of this module:
- Possess an understanding of the fundamental concepts of dynamic systems
- Analyze a road vehicle for its response when steered
- Understand the response of a road vehicle during drive and braking
- Characterize the response of vehicle suspension towards ride comfort, pitch, and roll analysis
- Have an exposure to key ideas from control systems

Applications of this module:
- This module would be useful in product development engineering and computer aided engineering applications in the Electric Vehicle (EV) design and development process
- The concepts learnt would help engineers analyze the dynamic response of an EV at the design stage, and the results could lead to potential re-design and control for improved vehicle performance

5 Battery Technology

Faculty Profile:
Prof. S. Ramanathan
Professor,
Dept. of Chemical Engineering,
IIT Madras

Faculty Profile:
Prof. Kothandaraman Ramanujam
Professor,
Dept. of Chemistry,
IIT Madras

Module Duration: 13 hours

Describe the module you are planning to deliver: This module on Battery Technology covers the electrochemical fundamentals of a battery, which includes materials, crystal structure of materials, where Li+ is intercalated; how a battery's cells are manufactured and put together; the battery management system; and the design, manufacturing and storage of battery systems.

Topics covered:

- Explain the electrochemical fundamentals and battery chemistry: next-generation batteries like Na-ion and Na-S will also be introduced
- Describe the cell manufacturing processes, and details of tests and measurements
- Modeling of batteries to estimate the state of charge and state of health are explained
- Safety aspects of lithium-ion batteries and various failure mechanisms are presented
- Options available for battery management systems and the implications are summarized
- Cost estimation using BatPac® tool is illustrated

Learning outcomes of this module:

- Understand the implications of various battery chemistries
- Interact well with cell manufacturers, and grasp the implications of changes in manufacturing processes
- Interpret the results of cell and battery testing
- Make informed choices on pack design and BMS selection, to enhance the performance without compromising safety
- Estimate the cost of various choices of battery chemistries

Applications of this module:

- The Battery Technology module is relevant to EV and battery manufacturers

6 Power Electronics

Faculty Profile:
Prof. Srikanthan Sridharan
Assistant Professor,
Dept. of Engineering Design,
IIT Madras

Module Duration: 7 hours

Describe the module you are planning to deliver: The module on Power Electronics deals with the processing and controlling of electrical power to provide various voltages and currents that are required in a given application.

Topics covered:
- DC–DC converters: Buck, Boost, bidirectional and interleaved converters
- Isolated DC–DC converters: Forward converter and Flyback converter
- DC–AC converters: Single-phase and three-phase inverters
- Pulse-width modulation (PWM): Selective Harmonic Elimination, Sinusoidal PWM, Third-harmonic injection

Learning outcomes of this module:
- Understand and analyze the operation of several fundamental power electronic circuits responsible for DC–DC conversion and DC–AC conversion

Applications of this module:
- Automotive electronics operating at different voltage levels
- Power converters for traction motor and auxiliary drives in EVs and HEVs

7 Motors for Electric Vehicles

Faculty Profile:
Mr. L. Kannan
Founder Director,
Motorz Design and
Manufacturing Private Limited

Module Duration: 5 hours

Describe the module you are planning to deliver: This module covers the physics of EV motors, the typical specifications that define their performance and ways to optimize them.

Topics covered:
- Introduction to Scientific Notations and Units
- Relationships Vs. Scaling
- Torque Produced by Motor & Torque Saturation
- Physics of a DC Motor
- Three Phase Circuits — A quick recap
- Speed of a motor — Electrical and Mechanical
- Property of a PMSM Motor
- Engineering Considerations

Learning outcomes of this module:
- To understand, analyze the principles of Permanent Magnet Synchronous Motor for electric vehicle application
- Understand the performance requirements of an electric vehicle and correlate them with the specifications of the traction motor
- Develop the specifications of a motor that would align with the demands of an electric vehicle — To select an appropriate motor
- Appreciate the key engineering constraints that impact the choice of a motor for a given EV application — such as Size, Cost, Efficiency, etc
- Develop a first-cut design of a motor that would meet the targeted performance of a EV
- To characterize and understand an out-of-shelf motor by using datasheets and specification sheets
- Understanding motor's technical and engineering considerations while designing and developing motors

Applications of this module:
- Ability to spec the motor needed for an EV application and select the one most suitable for it

8 Thermal Management for Electric Vehicles

Faculty Profile:
Prof. Srikanth Vedantam
Professor,
Dept. of Engineering Design,
IIT Madras

Faculty Profile:
Dr. Kaushal Jha
Adjunct Professor,
Dept. of Engineering Design,
IIT Madras

Module Duration: 13.5 hours

Describe the module you are planning to deliver: This module on Thermal Management is an important aspect of most industrial systems, and Electric Vehicle systems and sub-systems are not exceptions to this.

Topics covered:

- In EVs, systems like Li-ion battery pack, motors and controllers etc. need to be operated within specified temperature limits. If thermal management is not done effectively, it may lead to unsafe operation and could affect the performance, reliability and thus cost & affordability of the EV
- How to apply various thermal management techniques to build and optimise different types of EV thermal management systems

Learning outcomes of this module:

- Fundamentals of Thermodynamics and Heat Transfer
- Heat load/Cooling load Li-ion battery, Traction Motors and Controller, Power electronics
- Various types of thermal management techniques

Applications of this module:

- The Thermal Management module is relevant to EV and battery manufacturers

9 System Integration and Calibration

Faculty Profile:

Mr. Thiru Srinivasan
CEO, Center of Excellence in Advanced Automotive Research (CAAR),
IIT Madras

Module Duration: 4 hours

Describe the module you are planning to deliver : Vehicle is made up of several subsystems / components designed / selected based on specifications for the overall vehicle. These subsystems / components should be integrated into a vehicle and validated to ensure that the vehicle requirements are met – at every stage in the design and product development. This module focuses on the methodologies used in accomplishing this.

Topics covered:

- Vehicle System integration representations, maps and their relevance
- Requirements for Integration – Mechanical, Electrical Power, Signals, Analysis and Control
- Calibration between subsystems
- Testing, Validation and Certification / Approvals

Learning outcomes of this module:

- Appreciation for how the Vehicle subsystems work together into a full system resulting in the performance of the vehicle
- Gain understanding of the typical integration constraints and complexities, and methodologies to optimize the overall vehicle performance, cost etc
- Understanding how test methods relate to the vehicle requirements in the real world with respect to the test equipment and processes

Applications of this module:

- Systems Integration Reviews from early design stages, through development to product validation
- Product Performance testing, feedback and validation

10 Powertrain and Fuels

Faculty Profile:
Dr. Kaushal Jha
Adjunct Professor,
Dept. of Engineering Design,
IIT Madras

Module Duration: 3 hours

Describe the module you are planning to deliver: The powertrain is the most essential part of the vehicle, as it is responsible for the vehicle's movement. The energy to run the powertrain is an important consideration in the evaluation of a vehicle.

Topics covered:
- Fundamentals of powertrains and the forms of energy required to operate it
- Multiple powertrains architecture, both conventional or contemporary
- Understanding the effect of the powertrains and their fuels on environment through emission,cost and efficiency analysis

Learning outcomes of this module:
- Conventional and Contemporary powertrain used in automobile
- Energy sources to power up an automobile
- Various approaches to calculate the performance, efficiency and fuel/energy storage
- To lay/develop a foundation for energy conversion, efficiency, emission and renewables in an automobile

Applications of this module:
- This module will help professionals and researchers develop a fair understanding of powertrains and fuels, and will enable them to decide and move towards clean transportation
- The content of the module is relevant for both academic and industrial requirements

11 Charging Infrastructure

Faculty Profile:
Prof. Deepak Ronanki
Assistant Professor,
Dept. of Engineering Design,
IIT Madras

Module Duration: 5 hours

Describe the module you are planning to deliver: This module on battery charging technology covers the fundamentals and operation of various kinds of grid-connected battery chargers, their components, electric vehicle supply equipment, standards, charging protocols and communication.

Topics covered:

- Charging infrastructure challenges, types of electric vehicle supply equipment (EVSE), charger classification and standards
- Emphasis will be given to various configurations and architectures of onboard and offboard charging technologies
- Case studies along with an overview of upcoming techs and trends in battery charging infrastructure

Learning outcomes of this module:

- Understand how energy is pumped into the battery pack using various modes of charging
- Understand the fundamentals and overview of electric vehicle supply equipment, standards, charging protocols and communication
- Understand the requirements and various conversion stages in battery charging
- Familiarize with modern battery charging technologies

Applications of this module:

- Product development engineering with regard to battery charging technology, electric vehicle supply equipment and communication protocols

12 Materials for eMobility

Faculty Profile:
Prof. R. Jayaganthan
Professor,
Dept. of Engineering Design,
IIT Madras

Module Duration: 8 hours

Describe the module you are planning to deliver: This module will discuss materials utilized for fabricating various parts of an electric vehicle; ranging from battery pack, power electronic modules, motors, power train, suspension and regenerative braking system.

Topics covered:

- Materials utilized for fabricating various parts of an electric vehicle; ranging from battery pack, power electronic modules, motors, power train, suspension and regenerative braking system
- The electrical, thermal and mechanical properties of materials and its correlation with microstructure and testing procedures for generating these properties, which constitute design parameters will be covered
- Special emphasis will be given on battery materials, thermal interface materials, magnetic materials used for motors, and materials selection criteria for the specific application in Electric vehicles

Learning outcomes of this module:

- Expose basic concepts of materials science covering thermal, electrical, and mechanical properties of materials used for fabricating various parts of electrical vehicle
- Equip the electric vehicle design engineers with the selection criteria for choosing right materials to fulfill the manufacturability and the functional aspects of parts in EV

Applications of this module:

- This module is essential for the design and development of prototypes of various parts of Electrical vehicles. A thorough understanding of electrical, thermal, magnetic and mechanical properties of materials will enable design engineers to pick up right candidate materials for the manufacturing of battery packs, power electronic modules, and motors
- It will also enable design engineers to address the failure issues such as thermal runaway, leakage, and poor performance of life of battery pack and motors from the materials science perspectives besides design issues

13 Electromagnetic Compatibility for Electric Vehicles

Faculty Profile:

Prof. Kavitha Arunachalam
Professor,
Dept. of Engineering Design,
IIT Madras

Module Duration: 7.5 hours

Describe the module you are planning to deliver: This module will cover Electromagnetic compatibility for electric vehicles.

Topics covered:

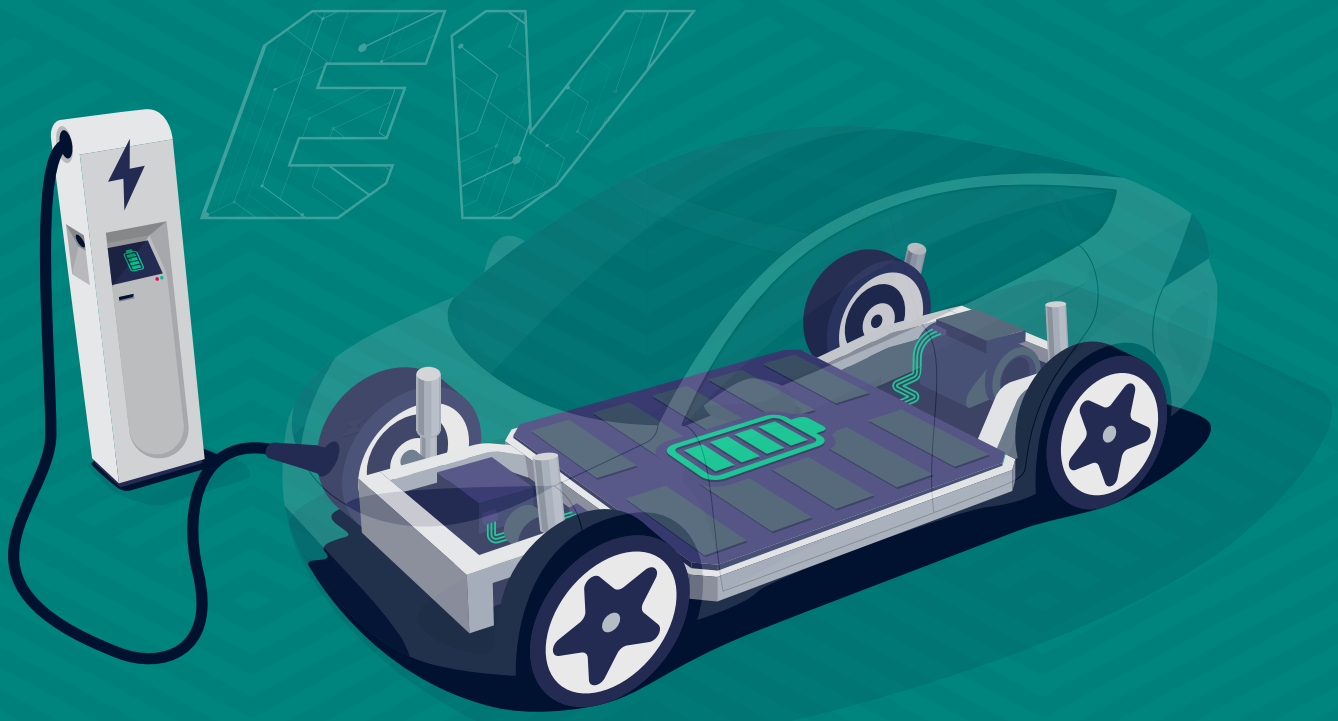
- Provide an overview of EM compatibility for product design
- Emphasis will be given to non-ideal behavior of electronic components commonly used in EVs, and the EMC directives

Learning outcomes of this module:

- To introduce non-ideal behavior of electronic components in a system; with emphasis on product design, and EMC directives for compliance aspects of electronic products

Applications of this module:

- Product development engineering of Electric Vehicles



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