



**Centre for Outreach and Digital Education**  
Indian Institute of Technology Madras



IIT Madras CODE offers Certificate Program on

# **MOTORS & CONTROLLERS**

Course Brochure

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# ABOUT THE COURSE

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Centre for Outreach and Digital Education (CODE), IIT Madras, offers a short-term executive certificate programme on Motors and Controllers.

The performance of an electric vehicle is primarily defined by its “engine” – the motor. Although motors have been known for over a century, EVs make far more exacting demands that have brought motors to the centre-stage of technology and set new benchmarks. All of these advances are driven by developments in power electronics and embedded firmware.

Most students and professional engineers in the automotive industry are bewildered by these rapid advances and unable to make informed decisions on the kind of motor that would be appropriate for a vehicle. This course seeks to demystify the “Multiphysics” of the motor and make the underlying ideas accessible. Spanning electromagnetics, thermal, hardware design and control algorithms, this course bridges the gap between academic theory and industry practice. The learners will be empowered to develop motors for vehicles of their choice through a specially curated software tool for design and simulation.

**Eligibility:** B.Tech (any domain) with interest in Automotive EVs

**Course Fees:** Rs. 47,200 (Rs. 40,000 + 18% GST)

**Course Policy:** Please refer [HERE](#) to read about policies on Admission, Pricing, Payment and Attendance.

**Cohort Size:** 100

**Mode of Course:** 28 hours of recorded videos and 12 hours of online live interactive sessions with the faculty

# FACULTY PROFILE

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## **Mr. L. Kannan**

Technology Director  
Centre of Excellence in Energy and  
Telecommunications (CEET),  
IIT Madras

Mr. L. Kannan has built motors and controllers for several applications including electric vehicles, industrial machines, power tools and domestic appliances. He approaches design from first principles, examining the interactions of different physics phenomena that impact the final performance, to develop solutions that are tailored for the target end-use.

His lectures on this topic are popular among students, faculty, and industry professionals.

CLICK HERE TO  
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## IITM CODE

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



# MODULES



# 01

## RECAP OF HIGH SCHOOL PHYSICS



### Description of the Module :

Fundamentals of physics underlying a motor

### Concepts Covered :

Ohm's Law, Magnetism, Thermal, Potential Divider, Three-Phase Circuits, Real and Apparent power, Faraday's law of electromagnetism, Torque and Speed Constants, Geometry-Free Visualization of Ohm's and Electromagnetism, Electrical, Mechanical and Magnetic Loading of a motor

### Learning Outcomes :

- Physics of torque production.
- Back-emf constant, torque constant and the relationship between them

### Applications of the Module:

Motor sizing based on torque density

MODULE

# 02

## MOTOR CONSTRUCTION



### Description of the Course :

Different components and geometrical features inside a motor

### Concepts Covered :

Physical Construction of a motor, Magnetic Path in a motor, Motor Sizing, winding pattern, Effect of pole pairs

### Learning outcomes:

Optimizing the geometry of a motor for torque production

### Applications of the Module:

Design and sizing of internal features of a motor

MODULE





## 03

# PERFORMANCE EVALUATION

### Description of this Module:

- Assessing the performance of a motor using torque and speed curves
- Impact of losses on temperature, efficiency

### Concepts Covered :

- Torque-Speed and Power-Speed Curves, Phase Resistance, Rated Operating Point, Conductive and Convective Temperature-rise, Efficiency, Motor Constant, Copper and Steel losses
- Effect of gearing

### Learning Outcomes:

Estimation of losses, efficiency and thermal effects

### Applications of this Module:

Evaluating how well the motor performs under different conditions of torque and speed



MODULE

## 04

# MOTOR CONTROL

### Description of this Module:

Closed Loop Control for optimal control of torque vs. speed curves

### Concepts Covered :

- Magnetic and reluctance torque, impact of phase-advance angle
- MTPA, and flux-weakening control schema.
- Feedback control Mechanism and Control Loops

### Learning outcomes:

Optimizing motor performance by controlling the phase-advance angle

### Applications of this Module:

Fundamentals of Closed Loop Control of a motor



MODULE

# 05

## VEHICLE DYNAMICS



### Description of this Module:

How do different vehicle parameters and driving conditions influence torque and speed requirement of an EV motor

### Concepts Covered :

Linear and Rotational Motion, Powertrains, Drive modes, Forces Acting on the vehicle, Velocity vs Time and Distance vs Time, Vehicle Dynamics Calculator

### Learning outcomes:

Estimating the speed, torque and power demands on the motor under different driving conditions

### Applications of this Module:

Deriving the specifications of the motor, based vehicle performance requirements

# 06

## MOTOR DESIGN



### Description of this Module:

- Overview of motor topologies
- Motor design and simulation tool

### Concepts Covered :

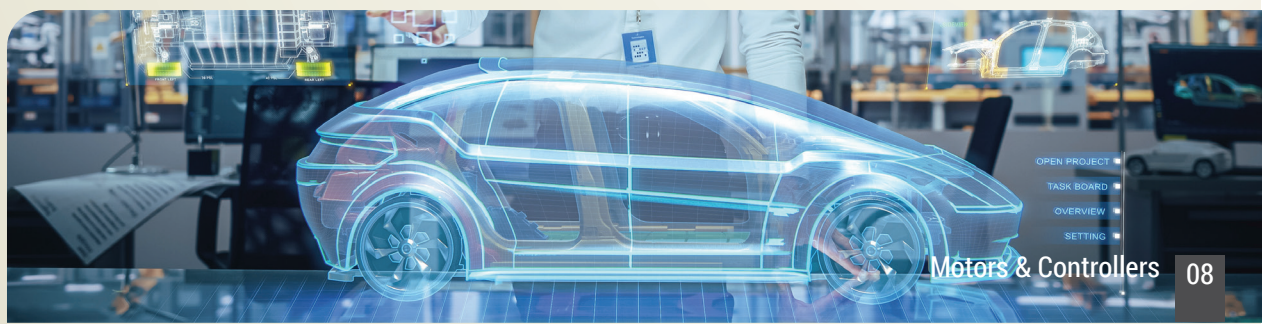
Motor design for a popular topology, using a cloud-hosted design and simulation tool

### Learning outcomes:

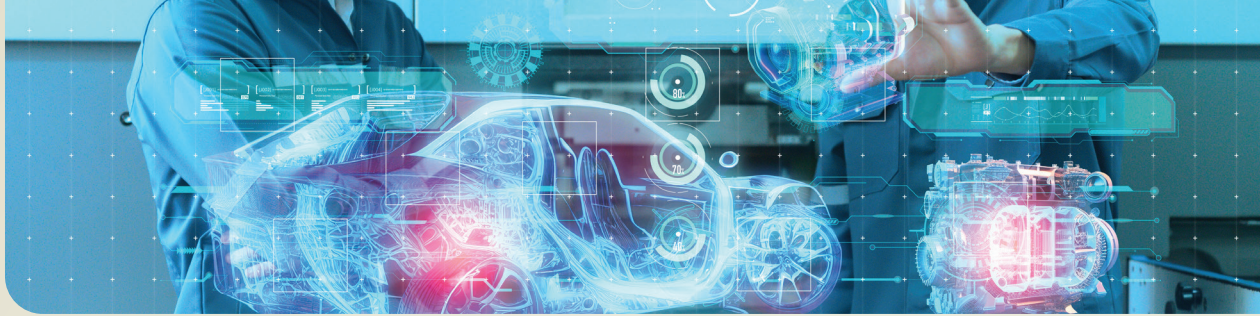
Design of a motor and its performance analysis

### Applications of this Module:

Detailed motor design developed on the basis of vehicle specifications







07

## CONTROLLER DESIGN

### Description of this Module:

Hardware and software design to implement closed-loop control of motor

### Concepts Covered :

- PWM, hex-bridge inverter, Controller architecture, current and voltage measurement, hardware and software filters, 6-step control, Field-oriented Control
- Firmware implementation – Clark and Park Transforms, Third Harmonic Injection, SVPWM

### Learning outcomes:

To understand the concepts of various control schemas and selection of appropriate control technique for an application

### Applications of this Module:

Identify the components of interest for the development of controllers for a PMSM motor control



MODULE

08

## ENGINEERING CONSIDERATIONS

### Description of this Module:

How to build a motor that meets user expectations of performance and life

### Concepts Covered :

Noise and Vibration, Ingress Protection, cogging torque and torque ripple, thermal design guidelines, Wavy washers contact resistance

### Learning outcomes:

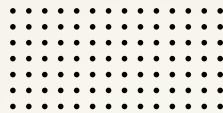
Practical considerations and good practices in motor manufacturing

### Applications of this Module:

Manufacturing guidelines for high-performance motors



MODULE



**Description of this Module:**

Contemporary challenges and design trends in the EV industry

**Concepts Covered :**

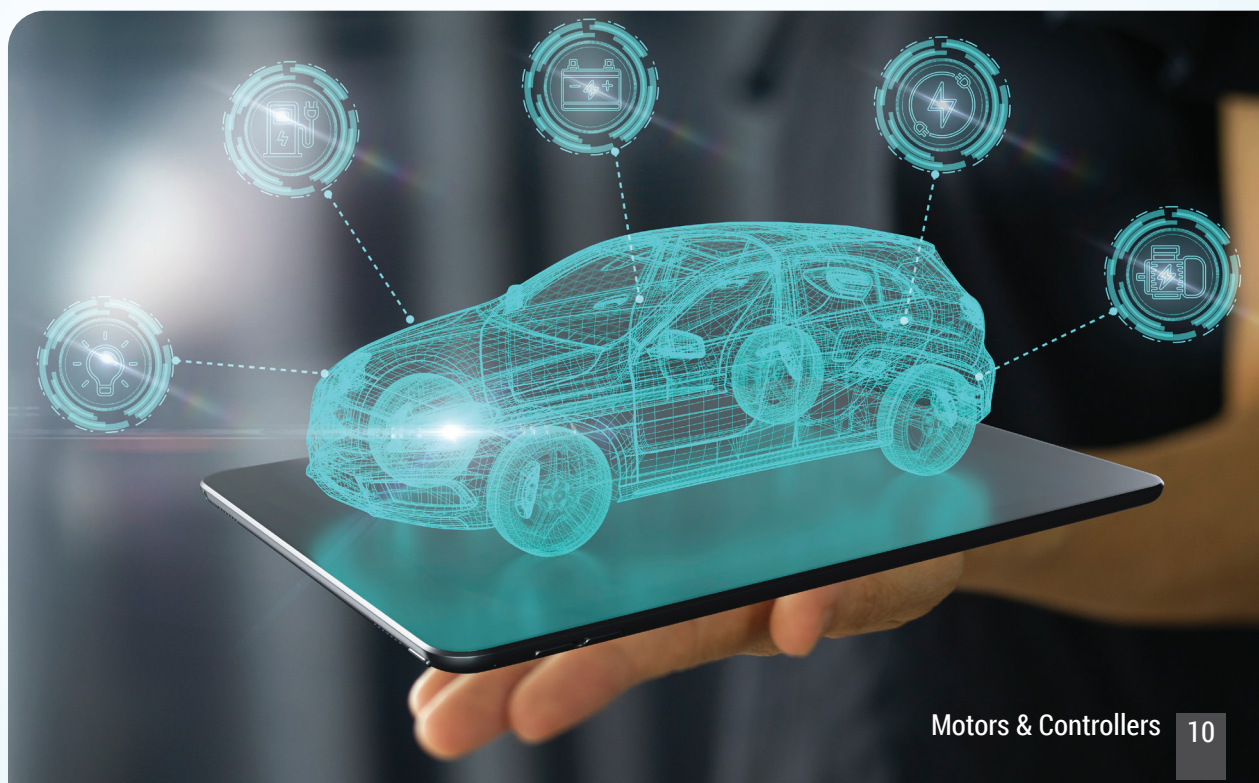
Tech Drivers, constraints of Materials and Manufacturing, Design Trends

**Learning outcomes:**

Roadmap for designs that enable strong market differentiation

**Applications of this Module:**

Visualizing the future evolution of this domain





### **Contact Us**

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