IIT Madras CODE offers Certificate Program on

MOTORS & CONTROLLERS

Course Brochure

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ABOUT THE COURSE

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

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.

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

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

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IITM CODE

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/
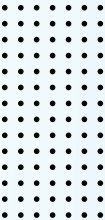
MODULES

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

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
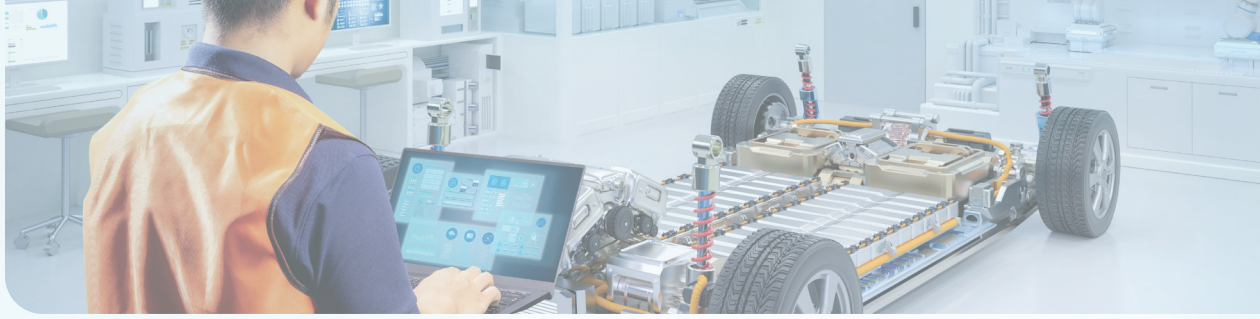
Learning outcomes:
Optimizing the geometry of a motor for torque production

Applications of the Module:
Design and sizing of internal features of a motor

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

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

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

MOTOR DESIGN

Description of this Module:
• Overview of motor topologies
• Motor design and simulation tool
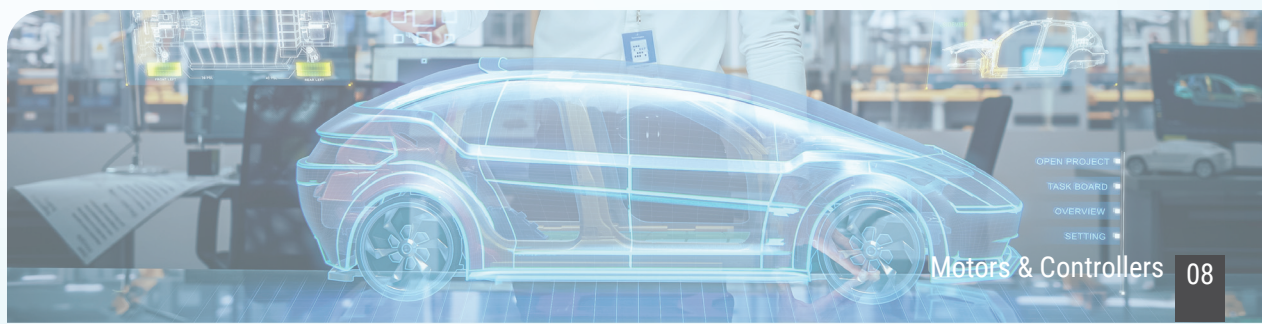
Concepts Covered :
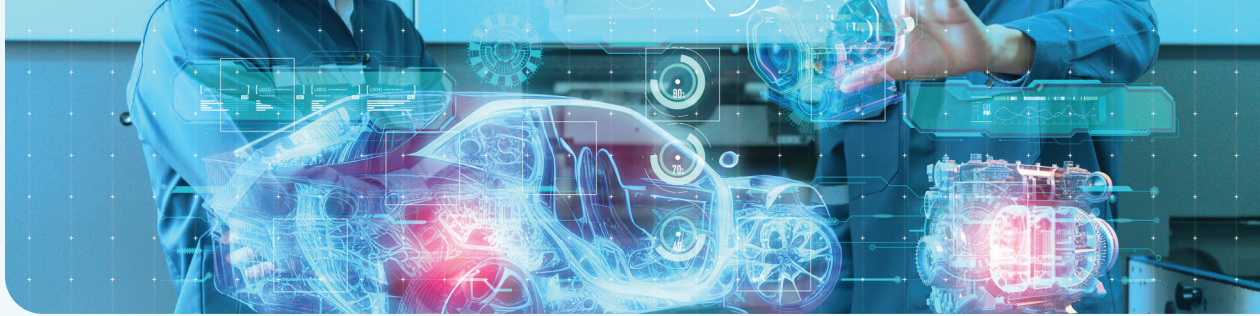Motor design for a popular topology, using a cloud-hosted design and simulation tool

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

08   ENGINEERING CONSIDERATIONS

Description of this Module:
How to build a motor that meets user expectations of performance and life
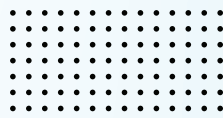
Concepts Covered :
Noise and Vibration, Ingress Protection, cogging torque and torque ripple, thermal design guidelines, Wavy washers contact resistance

Learning outcomes:
Practical considerations and good practices in motor manufacturing

Applications of this Module:
Manufacturing guidelines for high-performance motors

CONTEMPORARY TRENDS

Description of this Module:

Contemporary challenges and design trends in the EV industry
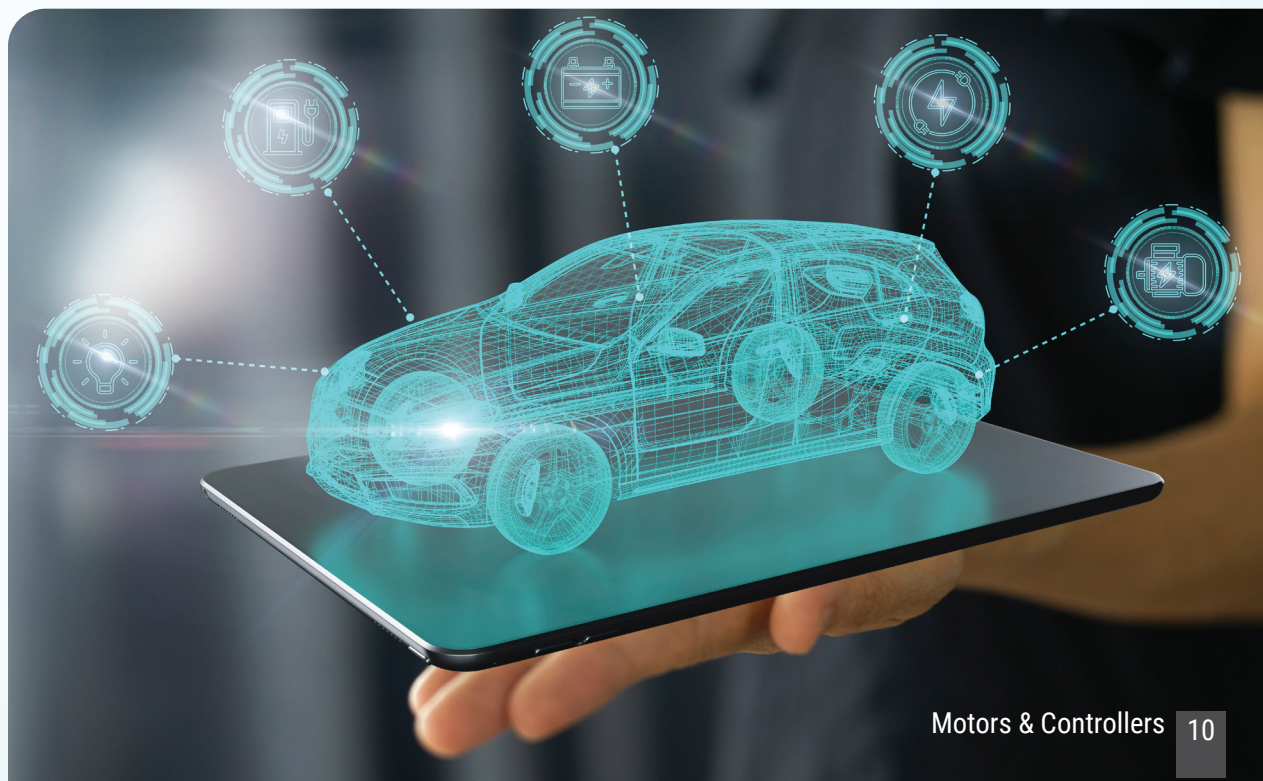
Concepts Covered :

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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