

Tutorial Title

Design & Optimization of High Torque Density Permanent Magnet Synchronous Machines for Traction Applications

Instructor Team

Team Chair: Mohanraj Muthusamy, Powersys, Inc.

Co-Speakers: Dheeraj Bobba, Powersys, Inc.

Mohanraj Muthusamy, Powersys, Inc.

Vedanadam Mudumbai Acharya, Powersys, Inc.

Abstract

Electric machines play a crucial role in traction applications, with high torque and power density being critical considerations in their design. This tutorial will highlight practical design considerations, trade-offs, and procedures for designing an electric motor to meet specific technical requirements using the JMAG FEA software. The tutorial comprises two main parts. The first part focuses on the foundational design aspects of an electric machine, covering aspects such as slot/pole selection and machine parameter determination, including overall dimensions, magnet specifications, coil configurations, current density, and flux density. A concept level design and analysis will be performed using JMAG FEA Package. In the second part, custom machine design will be imported / generated using JMAG and various performance metrics such as cogging torque, back EMF, average torque, torque ripple, and characteristic current requirements will be evaluated. Furthermore, efficiency map will be generated and compared. A coupled multi-physics-based optimization, encompassing both electromagnetic and structural considerations, will be performed to enhance motor performance. Finally, a comparison is drawn between the initial and optimized designs, using the JMAG FEA software package.

Instructor Team Biographies

Speaker 1:

Name: Mohanraj Muthusamy.

Mohanraj Muthusamy currently serves as an electromagnetic design engineer at Powersys in Montreal, Canada. He received his PhD in Electric Machine Design from Concordia University in Montreal, Canada. His research focuses on innovative magnetic materials, additive manufacturing, and loss-measuring techniques to enhance the efficiency and torque density of electric motors. He has also gained experience as a part-time magnetic designer at Dana TM4 in Montreal, Canada and as an electric machines research engineer at PSG College of Technology in Coimbatore. India.

Speaker 2:

Name: Vedanadam Mudumbai Acharya.

Ved Acharya is currently working as Engineering Manager at Powersys in San Diego, CA. He obtained



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his master's degree in electrical engineering from UNC Charlotte, USA. His research focus includes magnetic gears & electrical machines.

Speaker 3:

Name: Dheeraj Bobba.

Dheeraj Bobba is currently a Senior Electromagnetic Design Engineer at Powersys in Madison, WI. He obtained his PhD in Electrical Engineering and the University of Wisconsin – Madison and has held positions as Software Developer and Applications Engineer focusing on low-frequency electromagnetics in the past. His current research interests include high power density electric machine design, control, and optimization techniques focusing on traction and aerospace applications.