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

SPEAKERS

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About The Speakers:

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Mohanraj Muthusamy received the bachelor's degree in electrical engineering from Anna University, Chennai, India, and the master's degree in electrical engineering from Karunya University, Coimbatore, India, in 2014. He finished his Ph.D. degree in electrical engineering from Concordia University, Montreal, QC, Canada. He has worked as a junior Research Fellow with the PSG College of Technology, Coimbatore. Also, he has worked part-time as a magnetic design engineer at DANA TM4, Montreal. Currently, he works as an electromagnetic design engineer at Powersys Inc., Montreal.

ABSTRACT

Electric machines play an important role in traction applications; high torque and high-power density are important aspects that must be considered while designing an electric machine. This tutorial will emphasize practical design considerations, trade-offs, and design procedures to meet the required technical specifications of an electric motor using the JMAG FEA package. The tutorial will have three different parts. The first part presents the fundamental design of an electric machine, which includes the selection of slot/pole, and the selection of machine parameters such as overall diameter, stack length, magnet dimensions, turns per coil, parallel path, current density and flux density.

The second part presents the benchmarking of the Toyota Prius (2010) electric motor, and it presents the design steps of an example electric motor to meet the Toyota Prius (2010) specifications by considering the fundamental design aspects presented in the first part. Also, it presents the comparison of cogging torque, phase back EMF, average torque, torque ripple, and the characteristic current requirement to achieve optimal flux weakening for two different slot/poles which are designed to meet Toyota Prius specifications.

It also includes the efficiency map comparison at the base speed and maximum speed for both the slot/pole designs. The best slot/pole combination is selected for further analysis. The third part focuses on the coupled multi-physics-based (electromagnetic and structural) multi-objective parametric optimization for the selected best/slot pole to improve the electromagnetic performance of the motor. Finally, it compares electromagnetic performances between the initial and optimized designs.

iTEC2024