Guest Editorial: Robust Design and Analysis of Electric Machines and Drives

THE Special Section intends to collect ideas and recent advances from the global community in the field of improving robustness to uncertainty in the modelling, analysis and design of electric machines and drives, making possible the development of appropriate models for such components. When modelling electromechanical devices, electrical drives, and control apparatus, inevitable approximations and simplifications are required to allow for any kind of mathematical representations or performance predictions through numerical simulations. For example, such features as parasitic effects, external disturbances, sensor measurement errors, geometric details, construction defects, manufacturing tolerances, nonlinear behaviors or possible deviations in material properties and parameters often need to be neglected. All this leads to relatively idealized models, which cannot reflect the reality in a fully faithful fashion. When using such models for the purpose of analysis and design, unexpected or unwanted effects, such as prediction errors or failure to attain optimality, may arise. The challenge is to find suitable analysis and design approaches capable of assuring satisfactory results even in presence of uncertainties, thus featuring a good "robustness" with respect to modelling errors, inaccuracies, and inevitable tolerances.

Through this Special Section the robust analysis, design, and optimization of electrical drives (and energy conversion systems in general) under uncertainties have attracted attention and contributions from both industry and research communities, as these topics link theoretical research to industrial manufacturing and production practice.

The unquestionable success of the SS is demonstrated by the statistics: 167 abstracts have been received, and 64 full papers have been invited. After a selective review process, privileging quality and innovation as acceptance criteria, 27 papers have been finally selected for publication. The competence of the anonymous reviewers together with the scrupulous management of the review processes by the guest editorial team guarantee that the accepted papers can be considered the state-of-the-art for the topics addressed. At the end, the large number of valuable submissions received is very interesting and we are confident that the published papers will inspire and encourage the journal readership to start or continue working in this emerging field. Moreover, researchers from various parts of the world have been connected and new joint activities and collaborations have been started; therefore, in addition to the published material, the Special Section has brought many beneficial '*side effects*' to the technical community and will hopefully stimulate the development of proposed techniques, methods, approaches and ideas in forthcoming years.

Going into details, the Special Section opens with a '*survey-type*" paper entitled '*More Robust and Reliable Optimized Energy Conversion Facilitated through Electric Machines, Power Electronics and Drives, and Their Control: State-of-the-Art and Trends*', where the present developments on the technical area being dealt with are summarized, together with some future possible scenarios. The other 26 papers cover the following aspects:

Robust Design & Optimization of Electrical Machines

- Robust Design Optimization of Permanent Magnet Linear Synchronous Motor Based on Quantified Constraint Satisfaction Problem
- Parameter Design Process for a High-Speed Permanent Magnet Machine under Multiphysics Constraints
- Robust Design Optimization of a Five-Phase PM Hub Motor for Fault-Tolerant Operation Based on Taguchi Method
- Robust Electromagnetic Design of Double-Canned IM for Submergible Rim Driven Thrusters to Reduce Losses and Vibration
- Robust Design Optimization of Surface-mounted Permanent Magnet Synchronous Motor Using Uncertainty Characterization by Bootstrap Method
- Robust-Oriented Optimization Design For Permanent Magnet Motors Considering Parameter Fluctuation
- Robust Design Optimization of SPMSM for Robotic Actuator Considering Assembly Imperfection of Segmented Stator Core
- Robust Design and Optimization for a Permanent Magnet Vernier Machine With Hybrid Stator
- A Robust Design Methodology for Synchronous Reluctance Motors
- Multi-objective Robust Optimization of a Dual-Flux-Modulator Magnetic Geared Machine with Hybrid Uncertainties
- Methods to reduce the computational burden of robust optimization for permanent magnet motors

Modeling and Analysis of Electrical Machines and Drives Under Uncertainties

- Influence of Asymmetrical Stator Axes on the Performance and Multi-physical Field of Canned Permanent Magnet Machine for Vacuum Dry Pump with Vector Converter Supply

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- Calculation and Analysis of the Electromagnetic Field and Temperature Field of the PMSM Based on Fault-tolerant Control of Four-Leg Inverters
- Uncertainty Quantification and Sensitivity Analysis in a Nonlinear Finite-Element Model of a Permanent Magnet Synchronous Machine
- Managing Uncertainties of Permanent Magnet Synchronous Machine by Adaptive Kriging Assisted Weight Index Monte Carlo Simulation Method
- Quantifying the Impact of Tolerance-Affected Parameters on the Performance of Permanent Magnet Synchronous Machines
- Modeling and Analysis of Axial Flux Permanent Magnet Machines with Coexistence of Rotor Radial Deviation and Angular Eccentricity
- Analytical Model for Cogging Torque Calculation in Surface-Mounted Permanent Magnet Motors with Rotor Eccentricity and Magnet Defects
- Robustness to Large-Scale Mass Production Manufacturing Tolerances by Means of Sensitivity and Statistics Analysis for IPMSMs
- Sensitivity Analysis of Manufacturing Tolerances in Permanent Magnet Synchronous Machines with Stator Segmentation

System-Level Analysis and Robust Control Strategies

- Robust Predictive Current Control with Parallel Compensation Terms against Multi-Parameter Mismatches for PMSMs
- A Gain Design Method for a Linear Extended State Observers to Improve Robustness of Deadbeat Control
- Robust Predictive Torque Control of Permanent Magnet Synchronous Machine Using Discrete Hybrid Prediction Model
- Integral Sliding Mode-based Model Predictive Current Control with Low Computational Amount for Three-Level Neutral-Point-Clamped Inverter-Fed PMSM Drive System
- Influences on the Accuracy of Torque Calculation for Permanent Magnet Synchronous Machines
- Model-Free Predictive Current Control of a DFIG using an Ultra-Local Model for Grid Synchronization and Power Regulation

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GERD BRAMERDORFER, *Guest Associate Editor*
Johannes Kepler University Linz
Austria

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