Tutorial Title

From "PM" to "PM+X": Novel Variable Flux Machines for Wide-Speed-Range Applications

Instructor Team

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Co-Speakers: Yiming Shen, Nanyang Technological University

Abstract

This tutorial will begin by addressing the current challenges encountered by existing permanent magnet (PM) machines in wide-speed-range applications, with a specific focus on the restricted constant power speed range and diminished efficiency in the high-speed region. To overcome these challenges, a series of recently developed variable-flux PM (VFPM) machines will be introduced and examined, placing particular emphasis on recent advancements, future trends, and potential applications.
Furthermore, this tutorial will introduce the innovative "PM+X" concept, which entails the application of additional DC field excitation and variable flux magnets to conventional constant-flux PM machines. It will delve into the topology features, working principles, and control strategies of various types of new VFPM machines. Subsequently, the tutorial will delve into the challenges, opportunities, and potential applications of VFPM machines and drives.
This tutorial aims to provide a comprehensive introduction to the research and development of VFPM machines for researchers within academic communities. Moreover, it is anticipated that our research will have an immediate, direct impact on non-academic beneficiaries, including industry practitioners and motor manufacturers.

Instructor Team Biographies

Hui Yang received the B. Eng. degree from Dalian University of Technology, Dalian, China in 2011, and the Ph.D. degree from Southeast University, Nanjing, China in 2016, respectively, all in electrical engineering. From 2014 to 2015, he was supported by the China Scholarship Council through a one-year joint Ph.D. studentship at The University of Sheffield, Sheffield, U.K. Since 2016, Dr. Yang has been with Southeast University, where he has been an Associate Professor at School of Electrical Engineering. Since 2019, He serves as a Postdoctoral Fellow at School of Electrical Engineering, The Hong Kong Polytechnic University. His research interests include design and analysis of novel permanent-magnet machines with particular reference to variable-flux machines for electric vehicles and renewable energy applications. Dr. Yang has authored over 180 academic papers, with 37 of them being published in IEEE Transactions as the first author. He has received Best Paper Awards at ICEMS 2014, EVER 2015, and ICEMS 2019, and holds 25 patents. Currently, he serves as an Associate Editor for IEEE Transactions on Energy Conversion.

Yiming Shen obtained his B.Eng. and Ph.D. degrees in electrical engineering from the College of

Electrical Engineering, Zhejiang University, Hangzhou, China, in 2015 and 2020, respectively. During 2018 to 2019, he was a joint Ph.D. student at The Hong Kong Polytechnic University, Hong Kong. Following his doctoral studies, Dr. Shen served as a Postdoctoral Fellow at the College of Electrical Engineering, Zhejiang University, Hangzhou, China, from 2020 to 2022. Since 2022, he has held the position of Research Fellow at the School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore. His research focuses on the design and analysis of novel permanent magnet machines, with a specific emphasis on hybrid-excited machines for direct drive applications. Dr. Shen has authored over 45 academic papers, including 30 papers published in IEEE Transactions. Currently, he serves as an Associate Editor for IEEE Transactions on Industrial Electronics.