



Tutorial Title

Trends, Challenges, and Implementations of Model Predictive Control in Power Electronics

Instructor Team

Please insert the names, institutions, and emails of the chair and co-chairs (if any) of the proposed tutorial.

Prof. Marco Rivera, University of Nottingham, Nottingham, NG7 2RD, UK, E-Mail: Marco.Rivera@nottingham.ac.uk, Phone: +44 115 951 5151

Prof. José Rodríguez, Universidad San Sebastián, Santiago, CHILE, E-Mail: jose.rodriquezp@uss.cl

Prof. Emrah Zerdali, Ege University, TURKEY, E-Mail: Emrah.Zerdali@ege.edu.tr

Prof. Sergio Toledo, Universidad Nacional de Asunción, PARAGUAY, E-Mail: stoledo@ing.una.py

Prof. Patrick Wheeler, University of Nottingham, Nottingham, NG7 2RD, UK, E-Mail: Pat.Wheeler@nottingham.ac.uk, Phone: +44 115 951 5591

Abstract

In recent decades, the rapid advancement of modern microcontrollers has revolutionized power converter control, enabling the development and implementation of intelligent strategies beyond conventional techniques. Among these, Model Predictive Control (MPC) has emerged as a powerful and versatile alternative, garnering significant attention in both academia and industry. MPC offers numerous advantages, including its intuitive design, elimination of linear controllers and modulators, and seamless integration of nonlinearities and constraints into the control law. These features position MPC as a highly promising solution for tackling complex control challenges in power electronics and electrical drives.

This tutorial delves into the latest advancements and trends in MPC for power converters and electrical drives, highlighting its practical benefits and potential for widespread industrial adoption. Participants will gain insights into the fundamental principles of MPC, explore state-of-the-art applications, and learn about emerging opportunities for optimizing system performance. The session will provide a comprehensive understanding of how MPC is reshaping the future of power electronics and drives, bridging the gap between academic research and real-world implementation.

Instructor Team Biographies



Received the Electronic Civil Engineering degree and the M.Sc. degree in Engineering, with specialization in Electrical Engineering, from the Universidad de Concepción. Later he obtained a Ph.D. degree in Electronic Engineering from the Universidad Técnica Federico Santa María, and was awarded the “Premio Tesis de Doctorado Academia Chilena de Ciencias 2012”, for the best PhD Thesis developed in 2011 for national and foreign students in any exact or natural sciences program, that is member of the Academia Chilena de Ciencias, Chile.

He is the Director of the Laboratory of Energy Conversion and Power Electronics (Laboratorio de Conversión de Energías y Electrónica de Potencia, LCEEP) at Universidad de Talca, Chile. He was a full professor at the Department of Electrical Engineering at the Universidad de Talca. Since April 2023 he joined the Power Electronics, Machines and Control (PEMC) Research Institute of the University of Nottingham as a Professor. His main research areas are power electronics, renewable energies, advanced control of power converters, microgrids, among others. He has published more than 580 academic publications in leading international conferences and journals.



Emrah Zerdali (Senior Member, IEEE) received his B.Sc. degree from Pamukkale University, Denizli, Türkiye, in 2009, and his M.Sc. and Ph.D. degrees from Niğde Ömer Halisdemir University, Niğde, Türkiye, in 2011 and 2016, respectively, all in electrical and electronics engineering.

He was a Postdoctoral Researcher with the Power Electronics, Machines, and Control (PEMC) Research Group at the University of Nottingham, U.K., from 2023 to 2024.

He is currently an Associate Professor in the Department of Electrical and Electronics Engineering at Ege University, Izmir, Türkiye. He is also a Researcher with the Power Control Research Group in the Department of Electrical and Electronics Engineering at Niğde Ömer Halisdemir University, Niğde, Türkiye. His current research interests include electric machines and drives, model predictive control, speed-sensorless control, fault-tolerant control, and state/parameter estimation of electric machines.





Electronic Engineer graduated [Hons] from the Faculty of Engineering at the Universidad Nacional de Asunción (FIUNA), Paraguay. He obtained a Master's degree in Electronics with an emphasis on Instrumentation and Control at the Center for Scientific Research and Higher Education of Ensenada (CICESE) in Mexico. He holds a Doctorate in Engineering Systems from the University of Talca in Chile. Additionally, he is an affiliated research associate at the Department of Electronic and Mechatronic Engineering at FIUNA and a Categorized Researcher by the National Council for Science and Technology (CONACYT) from Paraguay.

He has authored more than 60 scientific publications in the field of Power Electronics and Energy Conversion, including prestigious conference proceedings and indexed journals. He is the Graduate Studies and Research Coordinator at the Department of Electronic and Mechatronic Engineering at FIUNA and a professor in the field of Control Systems at the Universidad Nacional de Asunción - Paraguay. In 2021, he was awarded the "Best Conference Paper Award" by the Industrial Electronics Society (IES) of the IEEE.



He received the Dr.-Ing. degree in electrical engineering from the University of Erlangen, Erlangen, Germany, in 1985. He has been a professor and President of Universities Federico Santa María, Andrés Bello and San Sebastián in Chile. He has co-authored two books and more than 1000 journal and conference papers. Dr. Rodriguez is a member of the Chilean Academy of Engineering. In 2014 he received the National Award of Applied Sciences and Technology from the government of Chile. In years 2014 to 2023, he has been included in the list of Highly Cited Researchers published by Web of Science.

His main lines of research are multilevel inverters, new converter topologies, control of power converters, adjustable-speed drives, renewable energy and electromobility.





Prof. Pat Wheeler received his BEng [Hons] degree in Electrical Engineering in 1990 from the University of Bristol, UK. He received his PhD degree for his work on Matrix Converters from the University of Bristol, UK in 1994. In 1993 he moved to the University of Nottingham and worked as a research assistant in the Department of Electrical and Electronic Engineering. In 1996 he became a Lecturer in the Power Electronics, Machines and Control Group at the University of Nottingham, UK. Since January 2008 he has been a Full Professor in the same research group.

He is currently the Director for Global Engagement in the Faculty of Engineering and the Head of the Power Electronics, Machines and Control Research Group. He was Head of the Department of Electrical and Electronic Engineering at the University of Nottingham from 2015 to 2018. He is a member of the IEEE PELs AdCom and is currently IEEE PELs Vice-President for Technical Operations. He has published over 950 academic publications in leading international conferences and journals.

