PRELIMINARY PROGRAM

2025

Sponsors: IEEE, IEEE Industrial Electronics Society, IEEE PES Power & Energy Society®, pels IEEE Power Electronics Society Powering a Sustainable Future, IAS IEEE Industry Applications Society

IEMDC

MAY 18 - 21

Westin Houston Memorial City

Houston, TX

AGENDA

SUNDAY | MAY 18

- REGISTRATION OPENS | MAGNOLIA FOYER | 7:00AM-6PM
- LONG TUTORIAL 1 | MAGNOLIA 1 | 8AM-11:30AM
- LONG TUTORIAL 2 | MAGNOLIA 2 | 8AM-11:30AM
- LONG TUTORIAL 3 | MAGNOLIA 3 | 8AM-11:30AM
- AM COFFEE BREAK | MAGNOLIA FOYER | 9:30AM-10AM
- LUNCH-ON OWN | 11:30AM-1PM
- SHORT TUTORIAL 4 | MAGNOLIA 1 | 1PM-3:00PM
- SHORT TUTORIAL 5 | MAGNOLIA 2 | 1PM-3:00PM
- SHORT TUTORIAL 6 | MAGNOLIA 3 | 1PM-3:00PM
- PM COFFEE BREAK | MAGNOLIA FOYER | 3PM-3:30PM
- SHORT TUTORIAL 7 | MAGNOLIA 1 | 3:30PM-5:30PM
- SHORT TUTORIAL 8 | MAGNOLIA 2 | 3:30PM-5:30PM
- SHORT TUTORIAL 9 | MAGNOLIA 3 | 3:30PM-5:30PM
- LIGHT WELCOME RECEPTION | WISTERIA BALLROOM | 5:30PM-6:30PM

MONDAY | MAY 19

MAY 19
EXPO HOURS: 4PM-7:30PM

- REGISTRATION | MAGNOLIA FOYER | 7:30AM-6PM
- SPEAKER READY ROOM | SUNFLOWER | 8AM-4PM
- SPEAKER'S BREAKFAST | HIBISCUS BALLROOM | 7AM-8AM
- CONFERENCE OPENING + PLENARY SESSION 1 | WISTERIA BALLROOM| 8AM-9:40AM
- AM COFFEE BREAK | MAGNOLIA FOYER | 9:40AM-10AM
- ORAL/SPECIAL SESSIONS | BREAKOUT ROOMS TBD | 10AM-12PM
- LUNCH-ON OWN | 12PM-1:30PM
- ORAL/SPECIAL SESSIONS | BREAKOUT ROOMS TBD | 1:30PM-3:30PM
- PM COFFEE BREAK | MAGNOLIA FOYER | 3:30PM-4PM
- EXPO OPENS | AZALEA BALLROOM | 4PM-7:30PM
- POSTER SESSION 1 | AZALEA BALLROOM | 5:30PM- 7PM
- STUDENT DEMOS | AZALEA BALLROOM | 5:00PM - 7:30PM
- EXPO RECEPTION | AZALEA BALLROOM | 5PM- 7:30PM

TUESDAY | MAY 20

MAY 20
EXPO HOURS: 12:00PM-5PM

- REGISTRATION | MAGNOLIA FOYER | 7:30AM-6PM
- SPEAKER READY ROOM | SUNFLOWER| 8AM-4PM
- SPEAKER'S BREAKFAST | HIBISCUS BALLROOM | 7AM-8AM
- PLENARY SESSION 2 | WISTERIA BALLROOM| 8AM-9:30AM
- AM COFFEE BREAK | AZALEA BALLROOM | 9:30AM-10AM
- ORAL/SPECIAL SESSIONS | BREAKOUT ROOMS TBD | 10AM-12PM
- EXPO OPEN | AZALEA BALLROOM | 12PM-5PM
- EXPO LUNCH | AZALEA BALLROOM | 12PM-1:30PM
- POSTER SESSION II | AZALEA BALLROOM | 1:30PM- 3PM
- STUDENT DEMOS | AZALEA BALLROOM | 1:30PM - 5:00PM
- PM COFFEE BREAK | AZALEA BALLROOM | 3PM-3:30PM
- POSTER SESSION III | AZALEA BALLROOM | 3:30PM- 5PM
- BANQUET | WISTERIA BALLROOM| 6PM-8PM

WEDNESDAY | MAY 21

- REGISTRATION | MAGNOLIA FOYER | 7:30AM-11:00AM
- SPEAKER'S BREAKFAST | HIBISCUS BALLROOM | 7AM-8AM
- ORAL/SPECIAL SESSIONS | BREAKOUT ROOMS TBD | 8AM-10AM
- AM COFFEE BREAK | MAGNOLIA FOYER | 10AM-10:30AM
- ORAL/SPECIAL SESSIONS | BREAKOUT ROOMS TBD | 10:30AM-12:30PM
- AWARDS LUNCH/CONFERENCE CLOSES| 12:30PM-2PM - SAFE TRAVELS!

ORGANIZING COMMITTEE

General Chair:
Yao Duan, *Toshiba International Corporation, USA*

Technical Program Chairs:
Jiangbiao He, *University of Tennessee, USA*
Vandana Rallabandi, *Oak Ridge National Lab, USA*
Guang-Jin Li, *The University of Sheffield, UK*
Pinjia Zhang, *Tsinghua University, China*
Malcolm McCulloch, *Oxford University, UK*

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Bilal Akin, *University of Texas, Dallas, USA*

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Christopher H. T. Lee, *Nanyang Technological University, Singapore*

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Alireza Fatemi, *General Motors, USA*
Venkateshwaran Laxminarayanan, *Nayak Corporation, USA*

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Nick Baker, *Newcastle University, UK*

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Local Chair:
Goutham Selvaraj, *Toshiba International Corporation, USA*

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Seungdeog Choi, *Mississippi State University, USA*

Outreach Chair:
Peter Liu, *Toshiba International Corporation*

Plenary Session Chair:
Huijun Gao, *Harbin institute of technology, China*

Thank you to all of the track chairs and many reviewers who served countless hours. You made it possible to accommodate all of our submissions this year!

STEERING COMMITTEE

Radu Bojoi (Chair) - *Power Electronics Innovation Center (PEIC), IEEE Fellow*

Antonio J. Marques Cardoso - *University of Beira Interior (UBI), Covilhã, Portugal*

Ali M. Bazzi - *University of Connecticut (UConn)*

Alireza Fatemi - *General Motors*

Ayman M El-Refaie - *Marquette University*

Gerard-Andre Capolino - *Université de Picardie Jules Verne (UPJV), Amiens, France*

Herbert Hess - *University of Idaho*

Dan M. Ionel - *University of Kentucky*

Leila Parsa - *University of California, Santa Cruz (UCSC)*

Michael Sedlack - *NRG Energy*

Osama Mohammed - *Florida International University (FIU)*

PLENARY SESSION 1:
MAY 19 | 8AM-9:40AM | WISTERIA BALLROOM

KEYNOTE 1: NEXT GENERATION ELECTRIC TRACTION DRIVES FOR MEDIUM AND HEAVY DUTY VEHICLES

Burak Ozpineci - *Section Head and Corporate Fellow, ORNL Oak Ridge National Lab*
May 19, 2025 | *8:10AM-8:55 AM* | *Wisteria Ballroom*

Burak Ozpineci earned his B.S. degree in electrical engineering from Orta Dogu Technical University, Ankara, Turkey, in 1994. He then completed his M.S. and Ph.D. degrees in electrical engineering at the University of Tennessee, Knoxville, in 1998 and 2002, respectively. Since 2001, he has been with Oak Ridge National Laboratory, where he began as a student and has held positions as a researcher, founding group leader of the Power and Energy Systems Group, group leader of the Power Electronics and Electric Machinery Group. He currently serves as a Corporate Fellow and the Section Head of the Vehicle and Mobility Systems Research Section. Additionally, he has a joint faculty appointment with The University of Tennessee. Dr. Ozpineci is a Fellow of IEEE.

KEYNOTE 2:

Dr. Mohammed Arefeen
MAY 19, 2025 | *8:55 AM-9:40 AM* | *Wisteria Ballroom*

With over 30 years of industrial experience in variable speed drives, automation and power electronics applications for various sectors, Dr. Arafeen is currently the Global Product Manager, Automation at Weatherford, a leading oilfield service company. In this role, he leverages his experience and expertise in digital control of power electronics systems to develop and commercialize innovative automation solutions for the oil and gas industry. Previously, Dr. Arafeen was the VP of Engineering at Power Sentry, a company that was acquired by Weatherford in 2023. There, he led the development and launch of the Electrical Ride-Through (ERT) technology and the On-Site Storage (OSS) technology, which provide reliable and energy efficient systems for oilfield operations. He also holds five patents and multiple awards for my technical contributions and innovations in the field of power electronics. Additionally, he is an IEEE Senior Member and a Six Sigma Green Belt certified professional, with over 50 publications in various conferences and journals. Dr. Arafeen is passionate about advancing the state of the art in power electronics and automation, and delivering value to our customers and stakeholders.

PLENARY SESSION 2:
MAY 20 | 8AM-9:30AM | WISTERIA BALLROOM

KEYNOTE 3: POWERING FORWARD AUTOMOTIVE ELECTRIFICATION

Dr. Sanjeev Naik - *Director, Energy & Propulsion Systems Research, GM*
May 20, 2025 | *8AM-8:45AM* | *Wisteria Ballroom*

Dr. Sanjeev Naik is Director of Energy & Propulsion System Research at GM. He has held multiple management and technical leadership positions in vehicle electrification, propulsion systems, controls, and active safety. Dr. Naik is a recipient of GM's Boss Kettering Award, the Charles McCuen R&D Award, and the Chairman's Honors Award. His technical interests are in developing innovative electric mobility solutions. He is an IEEE Senior Member, an SAE Member, and has several publications and over fifty patents. Sanjeev received his Bachelor's degree from IIT Bombay, India, M.S.E.E. from the University of Michigan, Ann Arbor, and Ph.D. from the University of Illinois, Urbana–Champaign, all in electrical engineering, and M.B.A. in corporate strategy from the University of Michigan, Ann Arbor.

KEYNOTE 4: SIMULATION ADVANCEMENTS FOR ELECTRIC MACHINE TECHNOLOGY AND APPLICATIONS

Mark Solveson **-** *Product Manager, Ansys*
May 20, 2025 | *8:45AM-9:30AM* | *Wisteria Ballroom*

Mark G. Solveson , Product Management, Ansys. Mark has many years of industry experience and numerous patents with the Research and Development Center at Eaton Corporation, where he specialized in the design and analysis of electromechanical devices. Today, he continues with simulation specialization using Ansys electromagnetic FEA and system simulation software for power distribution, automotive, off-road vehicle, healthcare, aerospace, and renewable energy industries. At Ansys, he worked as an Application Engineer, a Manager for the North America Application Engineering team, and now as Product Manager in the Electronics Business Unit responsible for Ansys Motor-CAD, Maxwell, and ConceptEV.

TUTORIAL 1

"Multiphysics Equivalent Circuit Modeling for Electric Machinery – From Macro-scale to Micro-scale"

Sunday, May 18
8:00AM - 11:30AM
Room: Magnolia 1

SPEAKER

Matthew Gardner

University of Texas at Dallas

SPEAKER

Baoyun Ge

Georgia Institute of Technology

SPEAKER

Peng Han

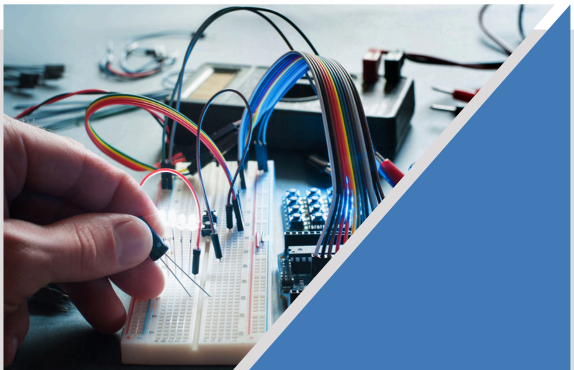
Ansys

Equivalent circuits have long been used to understand and analyze electric machines. Traditionally, these equivalent circuits, based on lumped elements capturing the main physical characteristics, have provided an intuitive way to explain electric, magnetic, and thermal phenomena. However, high-resolution analysis is necessary in high-fidelity virtual prototyping. To this end, finite element analysis (FEA) is usually the ultimate tool. In this tutorial, we illustrate a continuous spectrum from traditional macro-scale equivalent circuit modeling to micro-scale FEA using equivalent circuits.

First, a unified circuit view of multiphysics FEA for electric machines is presented. Specifically, FEA of electromagnetic, thermal, and elastic fields are viewed as constructing and solving equivalent circuits at the micro-scale (mesh) level. The RL and RC circuits familiar to electrical engineers are now transferred to physical processes beyond electrical circuits.

Secondly, we introduce recent advancements in magnetic equivalent circuit theory. A new element, magductance, can be used to account for eddy currents. The existence of magductance is indicated in the unified circuit view presented first. the electric power can then be calculated from the magnetic equivalent circuit. Examples using vector magnetic circuit theory, which employs reluctance and magductance, to design, analyze, and control various electromagnetic devices are presented.

Lastly, we discuss how to solve these equivalent circuits rapidly, which is necessary for micro-scale evaluation. We discuss using circuit-solving techniques to systematically and efficiently set up a matrix equation taking advantage of symmetric boundary conditions, how to efficiently solve the matrix equation, and how to solve nonlinear equivalent circuits.



BIOS

"Multiphysics Equivalent Circuit Modeling for Electric Machinery – From Macro-scale to Micro-scale"

SPEAKER

Matthew Gardner

University of Texas at Dallas

SPEAKER

Baoyun Ge

Georgia Institute of Technology

SPEAKER

Peng Han

Ansys

Matthew C. Gardner earned his B.S. in electrical engineering from Baylor University, Waco, Texas in 2014. He earned his Ph.D. in electrical engineering from Texas A&M University, College Station, Texas in 2019. In August 2020, he joined the University of Texas at Dallas, where he is an assistant professor. His research interests include optimal design and control of electric machines and magnetic gears.

Baoyun Ge received the B.E. degree in electrical engineering from Southeast University, Nanjing, China, in 2012, and the Ph.D. degree in electrical and computer engineering from the University of Wisconsin-Madison in 2018. For his Ph.D., he focused his research on the mathematical modeling and manufacturing of electrostatic machines. Dr. Ge received the First Prize Paper Award and the Third Place Thesis Award from the IEEE Industry Application Society (IAS) in 2017 and 2019, respectively. His work was also recognized by the Electrical and Computer Engineering Department at UW-Madison with the Harold A. Peterson Distinguished Dissertation Award. He received the CAREER Award from the US National Science Foundation in 2024. Dr. Ge served as guest associate editor for the IEEE Journal of Emerging and Selected Topics in Power Electronics and as invited topic and session chairs for the IEEE Energy Conversion Congress & Expo (ECCE). His research interests mainly focus on the design automation of electric machines and power electronics, multiphysics design and modeling, and advanced control architecture for electric machines and power electronics.

Peng Han is now with Ansys, Inc. as an Application Engineering Manager focusing on low-frequency electromagnetic products. He received the B.Sc. and Ph.D. degrees in Electrical Engineering from the School of Electrical Engineering, Southeast University, China, in 2012 and 2017, respectively. From November 2014 to November 2015, he was with the Department of Energy Technology, Aalborg University, Aalborg, Demark, where he focused on electric machines for wind energy conversion and high-power drives. He was a Post doctoral Researcher with the Center for High-Performance Power Electronics (CHPPE), ECE Department, The Ohio State University, and later the SPARK Laboratory, ECE Department, University of Kentucky. His current research interests include electric machines, machine drives, power electronics, consumer electronics, renewable energy and scientific machine learning. He was an Associate Editor for IEEE Transactions on Industrial Electronics, IEEE Transactions on Industry Applications and Journal of Power Electronics. He received two best paper/poster awards from IEEE conferences and Third Prize in the IEEE IAS Student Thesis Contest in 2018. He has instructed short courses/tutorials at ITEC 2022, IEMDC 2023, ITEC 2023 and ECCE 2023. He also delivered multiple training sessions for Ansys.

TUTORIAL 2

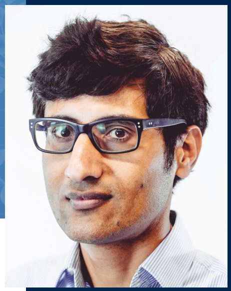
"Magnetic and Thermal Self-Commissioning Techniques for AC Motor Drives and Inverters"

Sunday, May 18
8:00AM - 11:30AM
Room: Magnolia 2

SPEAKER

Paolo Pescetto

Politecnico di Torino



SPEAKER

Shafiq Odhano

Newcastle University

SPEAKER

Marko Hinkkanen

Aalto University

SPEAKER

Luca Peretti

KTH

Accurate identification of motor drive parameters, including machine and converter characteristics, is essential in various applications. Precise measurement of these parameters is critical for validating machine design procedures and implementing model-based control schemes. Among these parameters, measuring flux saturation curves is especially crucial, as it significantly impacts drive performance. Additionally, understanding the operating limits of the drive necessitates thermal characterization, which plays a key role in optimizing efficiency and performance. Moreover, voltage source inverters introduce non-linear distortion of the phase voltage, which can impair control accuracy and limit performance, particularly in low-speed or sensorless applications.

While precise drive characterization can be achieved in a controlled laboratory environment, it is often impractical in industrial settings. This is due to the lack of dedicated testing facilities, the high variability caused by manufacturing tolerances, and time constraints on production lines. In such cases, a self-commissioning approach is commonly employed, where motor drive parameters are determined through fast, automatic tests. These tests are conducted with the drive directly mounted in its target application, without requiring additional measurement hardware beyond the drive itself. While self-commissioning tests provide lower accuracy compared to laboratory characterizations, they offer sufficient precision for calibrating motor control algorithms, even in sensorless applications.

This tutorial explores the state of the art in self-commissioning procedures for both synchronous and asynchronous motor drives, addressing both motor and converter characteristics. Special attention will be given to evaluating saturation characteristics and thermal parameters, as well as methods for compensating for non-linear voltage drops in the converter.

BIOS

"Magnetic and Thermal Self-Commissioning Techniques for AC Motor Drives and Inverters"

SPEAKER

Paolo Pescetto

Politecnico di Torino

SPEAKER

Shafiq Odhano

Newcastle University

SPEAKER

Marko Hinkkanen

Aalto University

SPEAKER

Luca Peretti

KTH

Paolo Pescetto is an Assistant Professor at Politecnico di Torino, Italy. He received the M.Sc. and PhD degrees with full grades and honors from Politecnico di Torino, Turin, Italy, in 2015 and 2019. Since fall2019, he has been working as a researcher and tenure-track lecturer in the Energy Department of Politecnico di Torino. He is a member of the Power Electronics Innovation Center (PEIC) of Politecnicodi Torino. He authored or co-authored 40+ scientific works, with 14 IEEE journal papers. Since fall 2022he has been the vice chair of the IEEE IA/IE/PEL North Italy Joint Chapter. His main research interests include synchronous motor drives, sensorless control, self-commissioning techniques, and integrated battery chargers for EVs. Dr. Pescetto received five IEEE paper Awards and two IEEE PhD thesis awards.

Shafiq Odhano is with Newcastle University, Newcastle upon Tyne, United Kingdom, where he is a lecturer in electric drives. He obtained his MSc and PhD degrees from Politecnico di Torino, Italy. He was previously affiliated with the Politecnico di Torino (Italy) and the University of Nottingham (United Kingdom) as a research fellow. His research interests include parameter identification for high-performance control of electric drives, fault-tolerant control of multiphase machines and drives, position sensorless control of synchronous motor drives and direct power control of doubly fed induction generators.

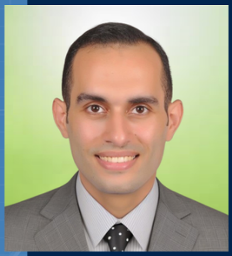
Marko Hinkkanen (IEEE Fellow) received the M.Sc.(Eng.) and D.Sc.(Tech.) degrees in electrical engineering from the Helsinki University of Technology, Espoo, Finland, in 2000 and 2004, respectively. He is currently an Associate Professor (tenured) with the School of Electrical Engineering, Aalto University, Espoo, Finland. His research interests include control systems, electric machine drives, and power converters. Dr. Hinkkanen was the co-recipient of eight paper awards and of the 2020 SEMIKRON Innovation Award. He was the General co-chair of the 2018 IEEE 9th International Symposium on Sensorless Control for Electrical Drives (SLED). He is an Associate Editor of IEEE Transactions on Energy Conversion and the IET Electric Power Applications.

Luca Peretti (IEEE Senior Member) received the M. Sc. degree in Electronic Engineering in 2005 from the University of Udine, Italy, and the Ph.D. degree from the University of Padova, Italy, in 2009. From August 2010 to August 2018, he was with ABB Corporate Research, Västerås, Sweden in different roles as principal scientist, project leader and strategy coordinator. He has also been an Affiliated Faculty member at KTH, division of Electric Power and Energy Systems, since July 1, 2016. Since September 2018 Luca is an Associate Professor at KTH, division of Electric Power and Energy Systems, in the field of Electric Machines and Drives. His main scientific interests relate to the automatic parameter estimation in electric machines, sensorless control, loss segregation in drive systems, multiphase drives, condition monitoring of machines and drives, in the context of industrial, wind energy, and traction applications.

TUTORIAL 3

"3D Printing for Next-Gen Electrical Machines: Magnetic Materials, Windings, Thermal Management, and Electrical Insulation"

Sunday, May 18
8:00AM - 11:30AM
Room: Magnolia 3



SPEAKER

Dr.Ahmed Selema

USP3D - Ghent University

SPEAKER

Prof. Dr. Peter Sergeant

Ghent University

This tutorial aims to explore the advancements and challenges in the manufacturability of electrical machines through the integration of 3D printing technology. The utilization of additive manufacturing (AM) technology in electrical machines has revolutionized the traditional manufacturing process, offering new design freedoms, enhanced material options, and the potential for complex geometries. This session seeks to bring together researchers and practitioners to share their latest findings, theoretical advancements, and practical insights in the realm of 3D printing technology applied to electrical machine design and manufacturing.

BIOS

“3D Printing for Next-Gen Electrical Machines: Magnetic Materials, Windings, Thermal Management, and Electrical Insulation”

SPEAKER

Dr. Ahmed Selema

Ghent University

SPEAKER

Prof. Dr. Peter Sergeant

Ghent University

Dr. ir. Ahmed Selema is a visionary innovator in smart and sustainable manufacturing technologies driving the future E-mobility. With over a 10 years of experience in electrical engineering, his career spans academia and industry, progressing from an engineer to academic staff and into industrial research and innovation. In 2020, he joined the electromechanical engineering from Ghent University, Ghent, Belgium where he received his Ph.D. degree. As an industrial research engineer at the Electrical Energy Lab (EELab), he has worked closely with leading industrial partners across Europe. He is also a Corelab Member in Flanders Make, the strategic research center for the manufacturing industry in Flanders, Belgium.

Currently, he works as technology director of USP3D, a spinoff from Ghent University (www.usp3d.be), where he leads the development of 3D-printed aluminum windings for electrical machines known for their market-leading efficiency, power density, and sustainability.

With a strong background in electrical engineering and additive manufacturing, Ahmed has been at the forefront of developing next-generation technologies for high-efficiency electrical machines. His expertise extends to pioneering manufacturing processes, including several technological contributions in the area of electrical machines and drives, thermal management, and, material engineering, 3D Printing.

Prof. Dr. Peter Sergeant received the M.Sc. degree in electromechanical engineering and the Ph.D. degree in engineering sciences from Ghent University, Ghent, Belgium, in 2001 and 2006, respectively. He became a Post-Doctoral Researcher at Ghent University in 2006 (Post-Doctoral Fellow of the Research Foundation-Flanders). Since 2012, he has been an Associate Professor at Ghent University. He is currently a Professor of electrical drives at Ghent University and the head of electrical machine research group affiliated to Flanders Make Core Lab. His current research domain is electrical machines and drives for industrial and for sustainable energy applications.

TUTORIAL 4

“Regenerative Motor Drive Systems for Industrial Applications”

Sunday, May 18
1:00PM - 3:00PM
Room: Magnolia 1

SPEAKER

Ahmed Sayed-Ahmed

Rockwell Automation

SPEAKER

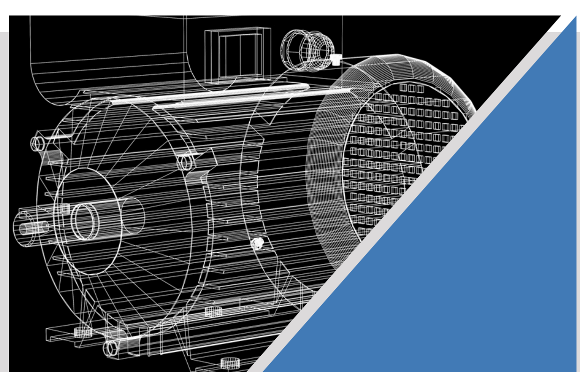
Yogesh Patel

Rockwell Automation

Over the last few decades, and especially with recent green energy initiatives, regenerative motor-drive systems have become more widely used in numerous industrial applications. The utilization of Active Front End (AFE) power converters coupled with inverters is one of the most accepted power electronic configurations for these drives. Although much attention is given to the design and control of AFE power converters in grid-tie applications, the same cannot be said for regenerative motor-drive applications.

The main advantages of adopting AFE-based power converters in regenerative motor-drive systems include the capability to supply energy back to the grid instead of dissipating excess energy in a resistor. This often requires additional cooling and space. They also offer unity power factor and low total harmonic distortion, which often results in reduced sizing of the main feeder, decreased system losses, and improved system efficiency. AFE-based power converters can also be properly controlled to inject reactive power compensation to the line, thereby enhancing the power factor of the entire utility.

This tutorial focuses on the design and analysis of industrial AFE-based power converters in regenerative motor-drive systems. It is divided into four main parts: the first part discusses type of adjustable drives, drives applications. The second part discusses power electronics and filter design, highlighting the main trade-offs in the design process along with thermal considerations; the third part centers on different modes of operation and control design; and the fourth part discusses technical application challenges associated with the deployment and operation of AFE-based power converters.



BIOS

"Regenerative Motor Drive Systems for Industrial Applications"

SPEAKER

Ahmed Sayed-Ahmed

Rockwell Automation

SPEAKER

Yogesh Patel

Rockwell Automation

Ahmed Sayed-Ahmed (S'05–M'09) received his B.Sc. and M.Sc. degrees in Electrical Engineering from Cairo University, Egypt, in 1998 and 2003, respectively. He earned his Ph.D. in Electrical Engineering from Marquette University, WI, USA, in 2009. He holds more than 30 US patents and has over 26 peer-reviewed journal and conference publications, including the IEEE Transactions on Energy Conversion prize paper award for 2012. His expertise is recognized by reputed institutions such as Marquette University and the Milwaukee School of Engineering, where he currently teaches several graduate and undergraduate classes in control design, power electronics, and electrical machines. Dr. Sayed-Ahmed is currently a Senior Principal Engineer and serves as a Product Owner at Rockwell Automation in the R&D Department. He has over 24 years of industrial and research experience, including control and design of motor-drive systems, embedded real-time control systems applied to power electronic applications, power system analysis, and the oil and gas industry. His current role involves leading and mentoring a highly energetic and dynamic technical team of control engineers to design and implement complex control algorithms for Rockwell's high-power regenerative motor-drive systems and compact drives.

Yogesh Patel (M'010) received his BS degree in electrical engineering from Maharaja Sayajirao University of Baroda. India and MS degree in Electrical Engineering from Illinois Institute of Technology, Chicago, 2003 respectively. He earned his Ph.D. in Electrical Engineering from University of Wisconsin Milwaukee, WI, USA, in 2012. He holds more than 20 US patents and has over 6 peer-reviewed journal and conference publications. Yogesh Patel is currently a Principal Engineer, and a Global Functional Lead at Rockwell Automation in the R&D Department. He has over 23 years of industrial and research experience, including adjustable speed drive design, power supply design, system configurations, and new product development.

TUTORIAL 5

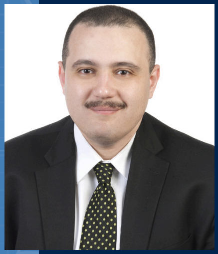
"High Power Density Motor Equipped with Additively Manufactured Windings Integrated with Advanced Cooling and Modular Integrated Power Electronics"

Sunday, May 18
1:00PM - 3:00PM
Room: Magnolia 2

There has been a special focus on aerospace electrification over the past few years. Electric machines and their drive systems have been at the center of these research efforts. Considering the power density and efficiency requirements for aerospace electrification, conventional machine/drive systems might not be feasible for such an application. To that end, the concept of integration of the machine, drive system, and cooling system known as Integrated Modular Motor Drive (IMMD) has been introduced.

On the power electronics side, the possibility of achieving high power density and efficiency is increased by the emergence of the wide band gap devices (WBGDs). Their intrinsic benefits such as low on-state resistance and fast turn on/off speed contribute to lower conduction and switching losses which in turn lead to higher efficiency. However, designing a proper thermal management system, optimized component placement, and optimal PCB layout is challenging due to processing high power at small footprints. On the machine side, the focus is typically on increasing the machine electric and magnetic loading as well as the mechanical tip speed. This can be achieved via novel machine topologies, advanced materials, advanced manufacturing as well as integrated systems with shared advanced cooling.

In this tutorial, the step-by-step design of a motor and its integrated drive system is presented. The advanced cooling system design for both motor and drive system is described. Finally, the overall integrated system is demonstrated, and test results are presented.



SPEAKER
Ayman EL-Refaie
Marquette University

SPEAKER
Nathan Weise
Marquette University

SPEAKER
Ali Al-Qarni
Marquette University

SPEAKER
Armin Ebrahimian
Marquette University

SPEAKER
Salar Koushan
Marquette University

SPEAKER
Seyed Iman Hosseini Sabzevari
Marquette University

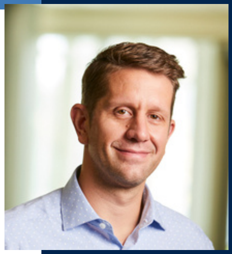
BIOS

"High Power Density Motor Equipped with Additively Manufactured Windings Integrated with Advanced Cooling and Modular Integrated Power Electronics"

SPEAKER

Ayman EL-Refaie

Marquette University



SPEAKER

Nathan Weise

Marquette University

SPEAKER

Ali Al-Qarni

Marquette University

SPEAKER

Armin Ebrahimian

Marquette University

SPEAKER

Salar Koushan

Marquette University

SPEAKER

Seyed Iman Hossei Sabzevari

Marquette University

Ayman EL-Refaie (Fellow, IEEE) received the B.S and M.S degrees in electrical power engineering from Cairo University, Giza, Egypt, in 1995 and 1998, respectively. He received the M.S. and Ph.D. degrees in electrical engineering from the University of Wisconsin-Madison, Madison, WI, USA, in 2002 and2005, respectively. Between 2005 and 2016, he has been a Principal Engineer and a Project Leader with the Electrical Machines and Drives Lab at General Electric Global Research Center. Since January 2017, he joined Marquette University as the Werner Endowed Chair for Energy Sustainability. He has over 160 journal and conference publications. He has 48 issued US patents. At GE, he worked on several projects that involved the development of advanced electrical machines for various applications including aerospace, traction, wind, and water desalination. His research interests include electrical machines and drives. Dr. EL-Refaie was the chair for the IEEEIAS Transportation Systems committee and an Associate Editor for the Electric Machines committee. He was a Technical Program Chair for the IEEE 2011 Energy Conversion Conference and Exposition (ECCE). He was the General Chair for ECCE 2014 and 2015 ECCE steering committee chair. He was the general chair of IEMDC 2019. He is the past chair of the IEEE IAS Industrial Power Conversion Systems Department and currently he is the IEEE Industry Applications Society Publications Department chair.

Nathan Weise (Senior, IEEE) is an associate professor at Marquette University in Milwaukee, Wisconsin. Dr. Weise has extensive academic and industrial experience pertaining to the design, building, and operation of high-power electronics. He was the lead PI of a DOE ARPA-E CIRCUITS program ($632,437) which is focused on high power density, high frequency, and high specific power converters utilizing wideband gap devices. The project developed a 1MW electric vehicle charger that charged an electric vehicle with 200-300 miles of range in two minutes. The project has ambitious goals of 1MHzeffective switching frequency, doubling of state of the art power density and doubling of state of the art specific power. Additionally, he is currently serving as the lead PI of an active DOE ARPA-EBREAKERS program ($500,000). This program focuses on realizing a novel DC circuit breaker for medium voltage systems. The project is developing an extremely fast less than 500 micro-second DC circuit breaker utilizing a novel actuator and current source with SiC and GaN devices. Furthermore, Dr. Weise and Marquette University competed in the Department of Energy Wave Energy prize as the team lead for the electrical engineering design and control system design. The team made it through multiple technology gates, became one of nine finalists, and finished in fifth place overall. Lastly, Dr. Weise was recently awarded, as a Co-PI, a project through the ARPA-EASCEND program which focuses its efforts on producing an all-electric propulsion system for commercial aviation applications.

Ali Alqarni (Student, IEEE) received the B.Sc. degree in electrical engineering from King Khalid University, Abha,Saudi Arabia, in 2015, and the M.S. degree in electrical engineering from the Marquette University, Milwaukee, WI, USA, in 2020. He is currently a research assistant and working towards his Ph.D.degree. His research interests include the analysis, design and optimization of magnetic gears, magnetically geared machines, advanced permanent-magnet machines, and ultra-fast actuators.

Armin Ebrahimian (Student, IEEE) received the B.S. degree in electrical engineering from the Ferdowsi University of Mashhad, Mashhad, Iran in 2014, and the M.Sc. degree in electrical engineering from Shahrood University of Technology, Shahrood, Iran in 2017. He began pursuing his Ph.D. at Marquette University, Milwaukee, WI in 2019. He has co-authored more than 18 conference papers and also has co-instructed tutorials and seminars in APEC, ECCE, and IEMDC. His current research interest includes design and digital control of high power density power electronic converters, Wide Band Gap Devices applications in power electronics, transportation electrification, and variable frequency drives.

Salar Koushan (Student, IEEE) received the B.Sc. degree in electrical engineering from the University of Tabriz, Tabriz, Iran, in 2014, and the M.Sc. degree from Middle East Technical University, Ankara, Türkiye, in 2020. Since 2021, he has been working toward the Ph.D. degree with Marquette University, Milwaukee, WI, USA. His research interests include the design and optimization of electrical machines, and electromagnetic analyses using FEA.

Seyed Iman Hosseini Sabzevari (Student, IEEE) received the B.S. and M.S. degrees in electrical engineering from the Ferdowsi University of Mashhad, Mashhad, Iran. He is currently pursuing a Ph.D. degree in electrical engineering with an emphasis on power electronics at Marquette University, Milwaukee, WI, USA. His research interests include control of power electronics converters, drive systems, electric vehicles, and the application of WBG devices in power converters.

TUTORIAL 6

"Innovative Approaches to Electric Motor Design: AI-Driven Reduced-Order Modeling and Geometry Optimization"

Sunday, May 18
1:00PM - 3:00PM
Room: Magnolia 3

SPEAKER

Philippe Wendling

Altair Co.

SPEAKER

Farid Zidat

Altair Co.

SPEAKER

Lavanya Vadamodala

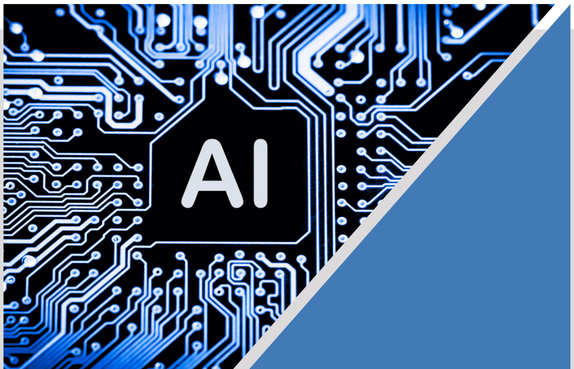
Altair Co.

This tutorial presents two innovative approaches to enhancing electric motor design and performance.

1. **Leveraging AI for Reduced-Order Modeling (RomAI):** We explore a hybrid methodology that combines finite element analysis (FEA) data with artificial intelligence (AI) to create reduced-order models. This approach aims to balance accuracy and computational efficiency, using an induction motor (IM) model as a case study. Participants will learn to integrate these techniques to improve efficiency calculations across various operating conditions.

2. **Optimizing E-Motor Geometry with Physics AI:** The second focus is on Physics AI, which identifies the relationship between shape and performance in physics applications. Users will be guided through optimizing the geometry of electric motors, specifically the Interior Permanent Magnet Synchronous Motor (IPMSM). The tutorial covers setting up a motor simulation dataset, developing an AI model, and refining the optimization process to achieve enhanced performance predictions.

By the end of this tutorial, participants will gain valuable insights into AI-driven modeling and geometric optimization techniques for electric motors.



BIOS

“Innovative Approaches to Electric Motor Design: AI-Driven Reduced-Order Modeling and Geometry Optimization”

SPEAKER

Philippe Wendling

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SPEAKER

Farid Zidat

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SPEAKER

Lavanya Vadamodala

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Philippe Wendling received his master’s degree from Ecole Central de Lille, Lille, France in1979. He is working as Vice President, GTT Electromagnetics Applications at Altair EngineeringInc. He is a Senior Lifetime Member of IEEE. His focus is modeling power generation, powerdistribution, and electromechanical power conversion applications in their Multiphysicsenvironment. Modeling for evaluation, design, or optimization in a sustainable world. He hasbeen involved in Finite Element modeling techniques of Electromagnetic Fields and Powerconversion devices and processes since the early 1980s. He is leading the technical supportand training activity. He is a frequent participant, session chair, committee member, andauthor at IEEE conferences, including CEFC, IAS, IEMDC, ECCE, and ITEC

Farid ZIDAT received his engineer degree in electrical engineering from UMMTO University(Algeria) in 2007. Then, he spent 4 years at Artois University (France) where he received his M.S. degree (2008) and his Ph.D. degree (2011). He was a member of the LSEE research laboratory. His research interests focus on the external magnetic field for diagnosis and on the efficiency of AC machines. He has joined the application team of CEDRAT on September 2011 as an application engineer specialist in electrical rotating machines simulations, since 2016 he is part of Altair Engineering. He is currently working on technical support, training courses, and several other issues associated with Altair EM Low Frequency solutions

Lavanya Vadamodala received her Ph.D. in Electrical Engineering from the University of Akron in 2021. She has been working as a Lead Solution Engineer at Altair Engineering, Inc. Her main fields are low-frequency electromechanical device design and analysis. Her current interests are Electromagnetics, Electric motor design, Optimization, and Multiphysics analysis. She has been participating in IEEE conferences like ECCE, ITEC, IEMDC, and APEC as an author, presenter, reviewer, session chair, and topic chair since 2018.

TUTORIAL 7

"Industrial Medium-voltage Drives: From Components to Systems and Applications"

Sunday, May 18
3:30PM - 5:30PM
Room: Magnolia 1

SPEAKER

Tobias Geyer

ABB System Drives, Switzerland

Medium-voltage drives are vital in decarbonizing the planet by generating renewable energy and electrifying transportation systems and heavy industry. This tutorial provides a comprehensive introduction, overview and assessment of such drives. A particular emphasis is laid on system aspects, integrating the transformer, converter, electrical machine and load into a high-performance drive system that is scalable, reliable and cost competitive.

To minimize the cost of such drive systems - or conversely - to maximize their hardware capability in terms of rated voltage and current, model predictive pulse pattern control (MP3C) offers a disruptive way of achieving this, as will be shown in this tutorial. The classic control methods, scalar control, field-oriented control and direct torque control will be introduced as well.

Medium-voltage drives are highly tailored to their specific application. As such, the understanding of the key drive applications is vital, including Marine propulsion, rolling mills of the Metals industry, crushers and mine hoists of the Mining industry, Wind power generation, and pumps and compressors used in the Oil and Gas industry.

This tutorial will introduce the exciting world of medium-voltage drive systems, it will showcase the opportunities they offer, will briefly introduce the quickly growing field of non-motoric applications and will point out challenging research problems for academics and researchers in industry alike.

BIOS

"Industrial Medium-voltage Drives: From Components to Systems and Applications"

SPEAKER

Tobias Geyer

ABB System Drives, Switzerland

Tobias Geyer is a Corporate Executive Engineer at ABB System Drives in Switzerland and R&D platform manager of the ACS6000 and ACS6080, the most well-known medium-voltage drive-in industry. His research interests are high-power converters and drives, optimized pulse patterns, and model predictive control. Dr. Geyer received the Ph.D. in control theory and the Habilitation degree in power electronics from ETH Zurich in 2005 and 2017, respectively. He was appointed as an extraordinary professor at Stellenbosch University in 2017 and has been teaching a course at ETH Zurich since 2016.

He has received six IEEE prize paper awards, filed about 90 patents, and co-authored more than 170 peer-reviewed publications. He has organized about 15 tutorials at international conferences and has given 8keynote lectures. Dr. Geyer has co-supervised more than 25 students, among them 8 PhD students. He is a former distinguished lecturer of PELS and a former associate editor of the Transactions on Power Electronics. Dr. Geyer is a Fellow of the IEEE.

TUTORIAL 8

“Current Source Inverters Using SiC and GaN Wide Bandgap Devices and Comparison with Voltage Source Inverters”

Sunday, May 18
3:30PM - 5:30PM
Room: Magnolia 2

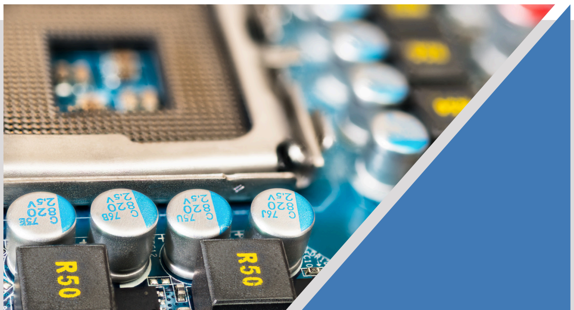
SPEAKER

Bulent Sarlioglu

University of Wisconsin-Madison, USA

Most recently, with the advance of state-of-the-art wide bandgap devices, the efficiency of the motor drives can be increased significantly compared to using Si devices such as IGBTs. The 2-level voltage source inverter (VSI) is the dominant choice for motor drive applications that are currently in production. However, there are some serious limitations experienced by VSIs when Si-based switches are directly replaced by WBG switches that are attributable to the extremely high dv/dt at the switch output terminals. These challenges include elevated electromagnetic interference (EMI) amplitudes, motor terminal over voltages, and bearing damage risks due to discharge currents. The emergence of WBG power devices opens opportunities for current source inverters (CSIs) to provide a promising alternative drive configuration for motor drive applications.

In this tutorial, the CSI will be introduced as a promising alternative approach for applying WBG switches in future motor drives that overcomes several of the key obstacles that hinder their use in conventional VSIs as well as offering some intriguing application advantages made possible by the special features of the CSI topology. The advantages and challenges of CSIs using WBG devices will be discussed. Special attention will be focused on the game-changing potential of M-BD switches in future CSI-based integrated motor drives. Finally, a comprehensive comparison between VSI can CSI with DC-voltage power source and sine voltage output will be introduced including passive components, output performance, efficiency, and volume. Two projects that applied the combination of wide-bandgap power switches and a CSI into an integrated motor drive using a high-performance PM synchronous motor will be presented as examples.



BIOS

"Current Source Inverters Using SiC and GaN Wide Bandgap Devices and Comparison with Voltage Source Inverters"

SPEAKER

Bulent Sarlioglu

University of Wisconsin-Madison, USA

Bulent Sarlioglu is a Professor at the University of Wisconsin-Madison and the Associate Director of the Wisconsin Electric Machines and Power Electronics Consortium. From 2000 to 2011, he was with Honeywell International Inc.'s Aerospace Division, Torrance, CA, USA, most recently as a Staff Systems Engineer. His expertise includes electrical machines, drives, and power electronics, particularly in electrifying transportation and industrial applications. He is the inventor or co-inventor of 20 U.S. patents and many international patents. In addition, he has more than 300 technical papers that are published in conference proceedings and journals. Dr. Sarlioglu received Honeywell's Outstanding Engineer Award in 2011 for his outstanding contribution to aerospace, the NSFCAREER Award in 2016, and the 4th Grand Nagamori Award from Nagamori Foundation, Japan, in 2018. Dr. Sarlioglu is involved in many IEEE activities. He served as the Chair of the PES Motor Subcommittee, Chair of the IAS Transportation Committee, Educational Activity Chair of the PELS TC4Electrical Transportation Systems, and one of the co-editors of the IEEE Electrification Magazine. Dr.Sarlioglu was nominated and selected to become a Distinguished Lecturer for the IEEE Vehicle Technology Society (2021-Present) and IEEE Industrial Application Society (2019-2021). Dr. Sarlioglu received the IEEE PES Cyril Veniott Award in 2021. Dr. Sarlioglu became a fellow for the National Academy of Inverters in 2021 and an IEEE Fellow in 2022.

TUTORIAL 9

"Design, Modelling and Mathematical Formulations of PM-Free Special Machines: from Theory to Practice"

Sunday, May 18
3:30PM - 5:30PM
Room: Magnolia 3

SPEAKER

Doga Ceylan

Eindhoven Univ. of Tech.

SPEAKER

Joost van Zwieten

Eindhoven Univ. of Tech.

SPEAKER

Mitrofan Curti

Eindhoven Univ. of Tech.

This tutorial provides a comprehensive introduction to modeling and designing special permanent magnet-free (PM-free) electric machines using open-source numerical tools, taking the participants from the mathematical concepts up to computation of performance indicators of these machines.

We begin by exploring the motivations behind these machines, outlining their advantages and trade-offs compared to traditional permanent magnet designs. The fundamentals of magnetic field theory are introduced, covering Maxwell's equations, magnetostatics, material models, losses, and performance computation methods.

The tutorial then delves into the capabilities of Python-based numerical library Nutils, outlining its application in solving complex electromagnetic problems. Participants will learn how to formulate and solve magnetostatic problems, including simple airgap model to familiarize them with the library, and finally, a reluctance machine example will be used to demonstrate how the losses, and torque production, among other features, are computed. Hands-on exercises guide participants through implementing these concepts using example scripts, enabling them to visualize magnetic field distributions, calculate inductances, and compute torque profiles.

This tutorial equips attendees with the knowledge and practical skills necessary to design and analyze rare earth PM-free electric machines effectively, leveraging the power of open-source tools, giving insights on the backbones functionality of numerical tools.

BIOS

"Design, Modelling and Mathematical Formulations of PM-Free Special Machines: from Theory to Practice"

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SPEAKER

Mitrofan Curti

Eindhoven Univ. of Tech.

Doga Ceylan received the B.Sc. and M.Sc. degrees from the Department of Electrical and Electronics Engineering, Middle East Technical University (METU), Ankara, Turkey, in 2016 and 2018, respectively, where he worked on multi-physical modeling of electromagnetic launchers and capacitive pulsed-power sources. He obtained his Ph.D. with cum laude from the Electrical Engineering Department of Eindhoven University of Technology (TU/e), in the Netherlands, in 2023. During his Ph.D. within the Electromechanics and Power Electronics (EPE) research group, he worked on the design and control of various types of reluctance machines for heavy-duty applications. He developed several analytical, numerical, and semi-analytical simulation models for nonlinear magnetodynamic problems, including laminated electrical steel. After his Ph.D., he was a Postdoc researcher at TU/e working on the development of a demonstrator prototype of a high-torque variable flux reluctance motor designed for agricultural electric tractors. He is currently an assistant professor at TU/e and continues his research on the multi-physical design of electromechanical systems, focusing on electric mobility and the development of novel control strategies applied to reluctance-based electrical drive systems.

Joost van Zwieten has a bachelor's degree in Electrical Engineering and a master's degree in Numerical Mathematics, both from Delft University of Technology. He started, but did not finish, a Ph.D. research project at the same university on Discontinuous Galerkin Finite Element discretization techniques of 1D multiphase pipe flow models. After leaving the university he joined the small consultancy company Evalf, whose main business is developing the open source Finite Element library Nutils.

Mitrofan CurtiCurti obtained his B.Sc.-degree in 2011 at Technical University of Moldova, M.Sc.-degree at Warsaw University of Technology in 2014. Mitrofan successfully defended his PhD in 2019 at the Technical University of Eindhoven. The research is focused on the analysis of the advantages and limitations of higher-order spectral elements applied to models of the electrical machines. Currently Mitrofan is an assistant professor in the field of electromechanical systems (EMS) in the group of Electromechanics and Power Electronics at TUE. In his team of over 6 PhD students, Mitrofan is involved in projects concerning magnetic material, insulation, and eddy currents characterization, in linear actuators an electric machines. His research is focused on combining efficient numerical schemes to model the material behavior exposed to extreme working conditions such as high frequency, voltage, and currents. In addition, Mitrofan is teaching a course on advanced actuators design where he covers design and modelling strategies in special actuators.

SPECIAL SESSIONS

SPECIAL SESSION 1: ROOM & TIME TBD

Development of Advanced Permanent Magnet Machines and Drives for E-Mobility

ORGANIZERS:

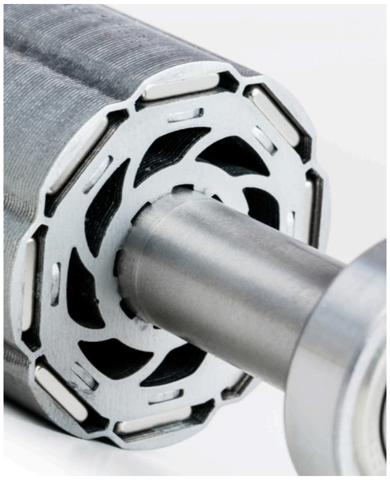
FENG CHAI | FULL PROFESSOR | HARBIN INSTITUTE OF TECHNOLOGY
YANLEI YU | RESEARCH FELLOW | NANYANG TECHNOLOGICAL UNIVERSITY

SPEAKERS:

JOSEP POU | PROFESSOR | CITY UNIVERSITY OF HONG KONG
FENG CHAI | PROFESSOR | HARBIN INSTITUTE OF TECHNOLOGY
YULONG PEI | PROFESSOR | HARBIN INSTITUTE OF TECHNOLOGY
XIN YUAN | ASSISTANT PROFESSOR | UNIVERSITY OF ABERDEEN
QINGXIANG LIU | RESEARCH FELLOW | NANYANG TECHNOLOGICAL UNIVERSITY
JINGWEI ZHU | RESEARCH FELLOW | NANYANG TECHNOLOGICAL UNIVERSITY

This special section highlights advancements in permanent magnet machines and drives for E-mobility. As modern transportation evolves, innovative solutions like electric vehicles (EVs), electric aircraft, and eVTOL aircraft are gaining global traction. Permanent magnet machines, as the cornerstone of propulsion systems, play a pivotal role in achieving the high efficiency and reliability demanded by these emerging technologies.

Meeting the stringent requirements of E-mobility, especially in aviation where weight isa critical constraint, necessitates propulsion systems with high torque density, robust fault tolerance, high efficiency, and precise control accuracy. These attributes are essential for delivering reliable power and consistent performance under diverse and demanding conditions. Fault-tolerant electric motors are particularly vital, as they mitigate risks during potential failures, enhancing safety and operational dependability. Thermal modeling and cooling system optimization are key to maximizing output performance. Advancements in theoretical modeling and simulation methods are crucial to improve motor pre-design accuracy, ensuring alignment between design parameters and practical requirements. Additionally, some emerging technologies, such as artificial intelligence (AI), are further enhancing computational efficiency in design and optimization processes. By integrating AI, designers can achieve more accurate predictions and faster iterations, accelerating the development of next-generation electric motors tailored to E-mobility needs.



The future of electric propulsion depends on systems that balance high torque density with exceptional fault tolerance. To drive progress in this field, we invite submissions to the special session, “Development of Advanced Permanent Magnet Machines and Drives for E-Mobility.” This session aims to provide a platform for researchers and practitioners to share cutting-edge advancements, address critical challenges, and explore new directions for E-mobility. Submissions should offer novel insights into both the theoretical and practical aspects of advanced permanent magnet machines and drives, contributing to the evolution of this transformative field.

SPECIAL SESSION 2: ROOM & TIME TBD

Novel Materials and Additive Manufacturing Techniques to Improve the Performance Limits of Electric Machines

ORGANIZERS:

DR. FNU NISHANTH, DR. VANDANA RALLABANDI, & DR. CHINS CHINNASAMY | OAK RIDGE NATIONAL LABORATORY

SPEAKERS:

AYMAN EL-REFAIE | WERNER ENDOWED CHAIR PROFESSOR | MARQUETTE UNIVERSITY

TOLGA AYTUG | SR. R&D STAFF | OAK RIDGE NATIONAL LABORATORY

ERIC SEVERSON | ASSOCIATE PROFESSOR | UNIVERSITY OF MINNESOTA

TODD MONSON | PRINCIPAL MEMBER OF THE TECHNICAL STAFF | SANDIA NATIONAL LAB

NICK SIMPSON | ASSOCIATE PROFESSOR | UNIVERSITY OF BRISTOL, U.K.

JUN CUI | PROFESSOR | IOWA STATE UNIVERSITY AND AMES NATIONAL LAB

The rapidly growing demand for more efficient, compact, and powerful electric machines is driving innovation in both materials science and manufacturing techniques. Electric machines are central to various applications, including electric vehicles (EVs), renewable energy systems, and industrial automation. However, the achievable power density, efficiency, and other performance metrics are limited by today's materials and manufacturing methods. This special session explores the potential of novel materials and advanced additive manufacturing (AM) techniques to push the boundaries of electric machine performance, addressing the challenges of energy efficiency, weight reduction, and cost-effectiveness.

New materials with enhanced electrical, magnetic, and thermal properties are at the fore front of electric machine innovation. For instance, advanced soft magnetic materials, ultra-conductors, and nanostructured materials are poised to dramatically improve the performance of components such as stators, rotors, and windings. These materials offer superior magnetic permeability, lower eddy current losses, and improved conductivity, leading to more efficient and power-dense machines.

Additive manufacturing (AM) presents a revolutionary approach for producing complex geometries and highly customized components, which were previously impossible or prohibitively expensive using traditional manufacturing methods. AM is a key enabler for the creation of electric machine components with optimized topologies, reduced material waste, and enhanced thermal and magnetic properties. These techniques also facilitate rapid prototyping and short production cycles, allowing for more flexible and cost-effective design iterations. The ability to produce complex multi-material structures using AM further enables the integration of novel materials within electric machines, offering customized solutions to specific performance needs.

Advanced materials and additive manufacturing techniques together present a paradigm shift in the design and production of electric machines. By enabling the development of components with enhanced performance characteristics, these innovations will help address the growing demands for higher power densities, energy efficiency, and reliability in a wide range of applications. This session will provide a platform for researchers, engineers, and industry professionals to explore the latest advancements, share insights, and discuss the challenges and future opportunities in utilizing novel materials and additive manufacturing for electric machine performance improvement.

SPECIAL SESSION 3: ROOM & TIME TBD

Advancing Rare-Earth-Free and Sustainable Electric Machine Design: Innovations and Applications

ORGANIZERS**:**

DR. BULENT SARLIOGLU | PROFESSOR | UNIVERSITY OF WISCONSIN-MADISON

DR. WOONGKUL LEE | ASSISTANT PROFESSOR | PURDUE UNIVERSITY

This special session will delve into pioneering advancements in the design, development, and application of rare-earth-free and sustainable electric machines. In response to the urgent demand for environmentally friendly and resource-efficient technologies, the session will focus on innovative materials, advanced topologies, recyclability, and methodologies that mitigate or eliminate the reliance on rare-earth elements while optimizing efficiency and performance. By bringing together leading researchers and industry experts, the session aims to highlight cutting-edge strategies and sustainable practices in electric machine design, fostering technological progress aligned with the global transition toward a sustainable and low-carbon future.

STUDENT DEMONSTRATIONS

Open: Monday, May 19 — **5:00pm - 7:30pm**
Judging: Tuesday, May 20 — **1:30pm - 5:00pm**

NEW FOR 2025! Student Demonstrations provide an opportunity for students from various universities and countries to showcase their emerging technology research outcomes and interact with academia and industry.

TABLE 1 | Real-Time Control and Comparative Analysis of a Lab-Prototyped Ultra-High-Speed (UHS) PMSM Using MATLAB for Embedded and dSPACE Systems

Demonstrators: Md Moniruzzaman & Md Rashedur Rahman
Mississippi State University, USA

TABLE 2 | Stator-Excited Synchronous Motors

Demonstrators: Oluwaseun Badewa, Ali Mohammadi, & Donovin Lewis
University of Kentucky, USA

TABLE 3 | Dual-Stage, Multi-Module Electric Machine for Electric Aircraft Propulsion

Demonstrators: Matin Vatani, Diego A. Lopez Guerrero & Oluwaseun A. Badewa
University of Kentucky, USA

TABLE 4 | AI-Driven Real-Time Fault Detection for Predictive Maintenance in Electric Drive Train

Demonstrators: Denizhan Demirkol
University of Tennessee - Knoxville, USA

TABLE 5 | Advanced High Power Density n-Layer Hairpin Winding Permanent Magnet Machine for EVs

Demonstrators: Wentao Zhang
Southeast University, People's Republic of China